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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

THE seventh annual meeting was held December 28 to 30, 1905, at Columbia University, New York. Some sixty members were in attendance and forty papers were on the program.

As usual, a number of pleasant social gatherings occurred during the meeting. On December 29 all lunched together in the department of astronomy, and in the evening were received by Mrs. Henry Draper at her house on Madison Avenue; many members also attended a dinner of the Mathematical Society and the Physical Society on the same evening.

The election resulted as follows:

President—E. C. Pickering.
First Vice-president—George E. Hale.
Second Vice-president—W. W. Campbell.
Secretary—George C. Comstock.
Treasurer—C. L. Doolittle.
Councilors for 1906–8—E. B. Frost and Harold Jacoby.

The council designated Harold Jacoby to act as editor for 1906.

We give below a list of papers presented at the society's sessions, together with brief abstracts furnished by the authors. Some of these have been slightly condensed by the editor.

PAPERS PRESENTED.

David Todd: 'Saturn as seen with the Eighteen-inch Clark Refractor of the Amherst College Observatory.'

S. I. Bailey: 'Some Variable Star Problems.'

Annie J. Cannon: 'Maxima and Minima of Variable Stars of Long Period.'

E. C. Pickering: 'A Systematic Study of Faint Stars.'

G. C. Comstock: 'Distribution of the Stars.'

F. H. Seares: 'Photometric Investigations.'

Mrs. W. P. Fleming: 'Some Peculiar Spectra.'

E. B. Frost: 'Burnham's Forthcoming General Catalogue of Double Stars.'

C. L. Poor: 'The Figure of the Sun.'

J. A. Parkhurst and F. C. Jordan: 'Photographic Photometry of Rapidly Changing Variable Stars.'

S. A. Mitchell: 'Spectrograms taken at Daroca, Spain, August 30, 1905.'

E. B. Frost: 'Observations of Radial Velocities of Stars.'

G. H. Peters: 'The Solar Corona, as observed by the U. S. Naval Observatory Eclipse Expedition, August 30, 1905, at Porta Coeli, Spain.'

N. E. Gilbert: 'Polarized Light in the Corona, Eclipse of 1905.'

C. C. Trowbridge: 'Resemblances between Persistent Meteor Trains and the Afterglow from Electrodeless Discharges.'

E. E. Barnard: 'Vacant Regions of the Sky.'

G. C. Comstock: 'A Proposed Method for the Wholesale Determination of Velocities in the Line of Sight.' (To appear in the *Astrophysical Journal.*)

E. C. Pickering: 'Determination of Absolute Positions of Stars by Photography.'

D. P. Todd and R. H. Baker: 'Local Predictions for the Total Eclipse of 1907 in Turkestan and Mongolia.'

J. A. Brashear: 'On Some Evidences of Permanent Set in Optical Surfaces.'

F. H. Seares: 'The Polaris Vertical Circle Method of Determining Time and Azimuth.'

Eric Doolittle: 'Determination of Adjustment Errors for the Polar Axis of an Equatorial.'

Eric Doolittle: 'The Hough Double Stars.'

David Todd: 'On the Practical Requisites for Securing Perfect Definition in Eclipse Photography.'

E. B. Frost: 'The Observations of Sun-spots by the late C. H. F. Peters.'

D. P. Todd and R. H. Baker: 'Computed Tracks and Totality-durations of Total Solar Eclipses in the Twentieth Century.'

A. O. Leuschner: 'An Analytical Method of Determining the Orbits of New Satellites.'

W. H. Pickering: 'Planetary Inversion.'

C. G. Abbot: 'A Standard Pyrheliometer and its Use on Mt. Wilson, California.' (Abstract in Science, XXIII., p. 203.)

B. L. Newkirk: 'Tables for the Reduction of Photographic Measures.'

R. T. Crawford: 'A Contribution on Astronomical Refractions.'

Sarah F. Whiting: 'A Solar Planisphere.'

B. L. Newkirk: 'Investigation of the Repsold Measuring Apparatus of the Students' Observatory, Berkeley, Cal.'

W. W. Dinwiddie: 'The 40-foot Camera of the U. S. Naval Observatory Eclipse Station at Guelma, Africa.'

C. D. Perrine: 'Polarized Coronal Light, August 30, 1905.'

F. Schlesinger and G. B. Blair: 'Anomalous Refraction.'

Henrietta S. Leavitt: 'New Variable Stars in the Small Magellanic Cloud.'

R. S. Dugan: 'Magnitudes and Mean Positions of 359 Pleiades Stars.'

David Todd: 'Results of Amherst Eclipse Expedition to Tripoli, 1905.'

M. B. Snyder: 'The Philadelphia Observatory and the Disastrous Fire of March 9, 1905.'

R. T. Crawford and A. J. Champreux: 'Orbit of the Seventh Satellite of Jupiter.'

Saturn as seen with the Eighteen-inch Clark Refractor of Amherst College Observatory: David Todd.

This new telescope, which has especially fine definition and a very dark field, was used the past autumn on the Saturnian system. Pending completion of the micrometer, to be employed on the satellites, attention was given particularly to the rings and ball. Differences of illumination in the detail of different zones of the rings were carefully observed and embodied in a drawing. The shadings of the belts on the ball were also set down in estimated positions, and a watch was kept for spots by which to determine anew the rotation time.

Totality-predictions for the Solar Eclipse of 1907, January 13–14, in Turkestan and Mongolia: David Todd and Robert H. Baker.

Attention is called to the importance of this eclipse in advancing our knowledge of the corona. Of eclipses in the immediate future, although a total one occurs every year from 1907 to 1912, that of 1907 is likely to be the most important because the paths of its successors are for the most part inaccessible. The best region for the 1907 eclipse is available by means of railways recently constructed in Russian territory. Also, about 600 miles northwest of Peking, the eclipse track is rather difficult of access in Mongolia. The writer has computed, among other things, the positions of ten possible stations, exact local times of the four phases, durations of totality, position angle of first contact, and sun's altitude and azimuth at middle of eclipse. (To be published in *The American Journal of Science.*)

Some Variable Star Problems: S. I. BAILEY.

About ten years ago more than five hundred variables were found in globular clusters; and further discoveries of this kind are possible with instruments of large size among the faintest stars in the clusters already examined, and in clusters which have not yet been searched.

The variables in the clusters Omega Centauri, Messier 3 and Messier 5 have now been studied. There are in these clusters 348 variables; for 273 of these periods have been determined, averaging about half a day. Changes in brightness are very rapid, and in many cases the regularity of the periods is so great that these stars would serve as good celestial time-keepers.

We have observed the clusters from five to twelve years, obtaining from five to ten thousand returns of maxima, so that periods are obtained which are correct within a few tenths of a second. For seventy-five of the variables periods have not been determined. Of these, sixty-five are too difficult, on account of nearness of other stars, smallness of the range of variation, or both. The remaining ten variables present peculiarities not yet understood.

While our observations for most of these variables are satisfied by a simple, uniform period, there are a number of cases in which it has been necessary to introduce a second term, implying a secular variation in the period. Several have been found which are best explained by the supposition that they are doubles, both components varying with the same period but with alternate maxima.

The presence of large numbers of variables in some clusters, and few, or none, in others, calls for an explanation. It may be that the axes of revolution of all members of such stellar systems are parallel. Variability, if associated with revolution, might then depend on the direction from which the system is seen. Stars which vary for us may be unvarying when seen from some other point in space. Again, variability doubtless marks an epoch in the development of stars. This epoch may be in the past for some, present for others, and future for still others.

The typical form of light-curve for variables in clusters is difficult to explain on the theory of axial revolution. But Dr. Curtis has shown recently that a relation exists between motion in the line of sight and variations in brightness in the case of W Sagittarii. Much may be learned by an extension of this research to other variable stars.

Maxima and Minima of Variable Stars of Long Period: ANNIE J. CANNON.

The original form of the bibliography of variable stars undertaken several years ago at Harvard College Observatory and for which all the material has been collected, was recently modified owing to duplication of much of the work by the Gesellschaft Committee in their proposed complete

'Catalogue of Variable Stars.' Tables of observed maxima and minima for class II., or long period stars, are now being printed. Proof sheets of such tables for stars between 0 and 6 hours right ascension are now submitted to the society. These tables give in successive columns, calendar date of the observed phase, Julian date, magnitude, name of observer, reference, epoch and residual from a period computed by a formula following the name of the star. Residuals have been calculated without the use of a second term in the formula: by plotting residual curves the form of correction to the period may often be found. Residual curves of *T Andromedæ*, o (omicron) *Ceti* and *S Ursæ Majoris* were shown to the society. The residual curve of *S Ursæ Majoris*, drawn from observations extending from 1843 to 1905, shows the need of a sine term in the formula. The residual curve of *T Andromedæ* is interesting in connection with the discussion concerning the period of this star soon after its discovery. Observations of *o Ceti* have extended over a longer time than those of any other long period variable. The residual curve, computed from observations since 1596, shows many irregularities and explains the difficulty of deducing a formula to represent the phases of this star.

It is hoped that these tables, by bringing together so much material in a convenient form, may prove of some use in investigating the variables of long period.

Systematic Study of Faint Stars: E. C. Pickering.

This paper described work that has been in progress at Harvard College Observatory, during the past five years, in studying the faint stars. The sky was divided into 48 exactly equal parts, as explained in detail in *Harvard Annals*, XIV., 477, and used in various publications of the observatory during the last twenty years. Portions of the sky, one degree square, in the centers of these regions, have been chosen for detailed study. The epoch employed is 1900. A sequence of fifteen stars of magnitudes 7.5 to 12.5 has been selected and measured with the twelve-inch meridian photometer, in each of these regions. Photographs have been taken with two hours' exposure, using the twenty-four-inch Bruce telescope, showing stars of magnitude 16, and brighter, and these have been enlarged to a scale of $20'' = 1$ mm. Photographs of the spectra with small dispersion, showing stars to magnitude 11, have been taken, and charts in and out of focus have been obtained. Photographs of these regions have also been made at the altitude of the pole, and for comparison the pole itself was photographed with the same exposure upon the same plate. The photographic magnitudes of all stars in the sequences mentioned above can thus be determined on the same scale. The measurement of photometric magnitudes from isochromatic plates is now in progress.

Nearly all photographs of the thirty-six regions north of declination $-30°$, and many of the others, have been completed; the entire work would probably have been finished, had the appropriation of 1902 been continued.

Distribution of the Stars: Geo. C. Comstock.

This paper deals with the extent of the visible universe and with the arrangement of the stars composing it. The data available and utilized for the discussion are of two kinds, (*a*) the number of stars per square degree of the sky as shown by the enumerations and gauges of Pickering, Argelander-Seeliger, Celoria and the Herschels, extending from the brightest stars down to the faintest visible in the Herschel telescope, about the fourteenth magnitude;

and (*b*) the average distances of the stars of each individual magnitude. These distances are obtained from a combination of the velocity with which the solar system moves through space and the resulting apparent displacement of the stars in the sky, the solar motion being determined spectroscopically and the displacement of the stars by means of the meridian circle. Kapteyn has obtained in this way the mean distances of stars from the third to the ninth magnitude; the present paper supplements this by a new determination of distances for stars between the ninth and eleventh magnitudes.

Based upon a part only of the above material, current astronomical doctrine affirms that the visible universe is a stellar system of limited extent whose boundaries, at least in some directions, lie within reach of our present telescopes. This view is opposed in the present paper, where it is pointed out that the evidence in favor of limited extent is obtained by ignoring two important factors of the problem; when these factors are taken into account the supposed evidence vanishes.

The first, and more important, of these factors relates to the intrinsic brightness of the stars. It has been commonly assumed that the fainter stars appear faint because of their greater distance from the earth and that there is no reason to suppose them to be intrinsically less luminous than the bright ones. The first part of this statement is unquestionably correct as far as it goes; the second part is wholly wrong. The faint stars, according to the writer, are less luminous than the bright ones, and stars of any given magnitude emit, on the average, only ninety per cent. as much light as do stars a magnitude brighter.

The second factor omitted in previous discussions is not here ignored, but rejected as useless. The known existence of dark matter or cosmic dust scattered through space leads naturally to the supposition that it may in some manner affect the transparency of interstellar spaces and cause an appreciable diminution in the light of fainter stars. Although this view has been rejected from current theories, it is evident from mathematical discussion of the data here considered that there is such an absorption and that approximately five per cent. of light is lost in transmission over a distance equal to a million times the diameter of the earth's orbit.

In abandoning the concept of a stellar system of limited and measurable extent the writer considers, provisionally, the consequences that result from the hypothesis of a system indefinitely extended on every side, with substantial uniformity in the direction of the Milky Way but thinning out on either side of the Milky Way, because the stars are here less numerous, or less brilliant, or because a denser cosmic dust more effectually quenches their light. It is impossible, now, to decide between these alternatives, but something of the kind is operative, and any one of the alternatives or a combination of all suffices to explain every feature of the stellar system for which the current theory accounts. The new hypothesis also brings out features hitherto unrecognized or unexplained.

The stars are not all of one kind, but differ among themselves in physical condition and properties which the spectroscope is able to detect and analyze. By far the larger part of the stars fall into one of two classes which the spectroscopists designate as type I. and type II., and which they regard as different stages of development of the individual, a star of type I. passing over with increasing age into type II. Now Pickering has shown recently that these stellar types are not scattered in-

discriminately throughout the sky, but that the younger stars, type I., show a more pronounced tendency to cluster along the milky way than do the mature ones, and this tendency grows more and more pronounced with diminishing brightness of the stars. It is difficult to see why this should be so; why one part of the universe should lag behind the rest in development, but the new hypothesis indicates at once that such is not the case. The distribution found by Professor Pickering is only an apparent one depending upon the known fact that the type I. stars are intrinsically brighter than their companions of type II. This fact alone in a system such as is here supposed would produce an increasing accumulation of faint, and therefore distant, stars of this type in the region adjoining the milky way, although, in fact, the two types may be everywhere distributed with a uniform ratio of frequency.

Other matters can be touched upon here in a summary way only. It is an immediate consequence of the present hypothesis that any considerable group of stars in a part of the sky remote from the milky way must on the average be nearer to us than a group of similar stars in the milky way. Although this relation has not been recognized hitherto, the writer finds from his own observations of faint stars between the ninth and twelfth magnitudes that such is the fact, the stars in the milky way being twenty-eight per cent. more distant than the mean of all other stars. It is commonly stated that the brightest stars emit an amount of light enormously greater than that given by the sun, 1,000 or 10,000 times as much, but from the measured magnitudes and distances of the stars it appears that while the large majority are brighter than the sun, few if any are more than two hundred times as bright.

Much of the investigation contained in this paper is summed up in a series of formulas, one of which shows the number of stars in the sky that are brighter than a given magnitude, *e. g.*, the tenth. Another shows the average distance of the stars of any assigned magnitude. A partial proof of the substantial accuracy of the numerical work contained in the paper is found in the fact that this last formula, although based solely upon distances of the fainter stars, derived by an indirect process, is in excellent agreement with the directly measured distances of the brightest stars.

Photometric Investigations: F. H. Seares.

This paper is a summary of results in an investigation of the wedges belonging to a Pickering equalizing stellar photometer. Two wedges were examined; one of photographic film, the other of shade glass. Absorption curves were determined by means of a disc photometer. The magnitude scales underlying these curves were then compared with that of the Müller and Kempf catalogue of Pleiades stars. Magnitude differences of twenty-one pairs of stars were measured and the results compared with the catalogue. The stars observed range from 7.24 to 10.76 magnitudes; the magnitude differences, from 0.80 to 3.52 magnitudes, with an average of 1.8 magnitude.

Eight observations were made with the shade glass wedge upon each pair. With three exceptions, each pair was measured upon at least four different nights. The results for this wedge are: P.E. of a single observation of four comparisons, $\pm$ 0.066 mag.; average deviation of mean magnitude difference from the catalogue difference, 0.07 mag.; deviation of wedge magnitude scale from the scale of Müller and Kempf, for the range 8.2–10.0 magnitudes, + 0.028 mag. The scale agreement is to be considered satisfactory, since the deviation is not greater than may arise from personality alone.

Results for the photographic wedge were derived from five observations upon each pair, measured on three nights. The results are: P.E. of a single observation of four comparisons, ± 0.078 mag.; average deviation from the Müller and Kempf magnitude difference, 0.12 mag.; scale difference, — 0.073 mag. The two scales can be brought into agreement by multiplying the ordinates of the absorption curve of the photographic wedge by the factor 0.961.

The photographic wedge has been discarded in favor of that of shade glass.

Details of the investigation are to be found in Laws Observatory Bulletin No. 7.

Some Peculiar Spectra: Mrs. W. P. FLEMING.

The examination of stellar spectrum photographs at Harvard College Observatory, forming part of the work of the Henry Draper Memorial, has enabled us to follow new stars until they became gaseous nebulæ, too faint for observation. Since we can pass from gaseous nebulæ to stars of class O, or type V., in which characteristic bright lines extend from wave-length 4600 to 4800, thence to stars having several hydrogen lines bright with dark lines of helium also present, and from the latter through classes B, A, F, G, K and M, we may assume that we have a key to the formation of the stellar universe.

In putting together results from an examination of variable stars whose spectra are of class Md it was found that a few stars were assigned to several subdivisions extending from Md 1 to Md 10, the most marked case being *S Carinae*. Further examination showed actual changes in the spectrum, which probably (as in the case of *β Lyræ*) follow closely the variations in light. *R Scuti* also shows changes, and quite recently *R Cygni*, another long period variable, has been added to this list.

The spectrum of the star (now known to be a gaseous nebula) — 12° 1172, mag. 9.2, when found on Harvard photographs, has always led to an examination of the list of novæ before that of nebulæ, since in this spectrum the bright nebular lines at wave-lengths 5003 and 5007 are quite faint, the hydrogen lines, Hξ, Hϵ, Hδ, Hγ, and Hβ are bright and of normal intensity, while the most marked feature is the broad bright line at wave-length 3724. This is not generally well defined in photographic spectra of gaseous nebulæ, in which the strong line in the violet end is 3868, of slightly shorter wave-length than Hξ.

The star *Z.C.* 18^h 1935, mag. 9, shows a peculiar form of spectrum not yet assigned to its class. The continuous spectrum contains strong, dark bands of which the most marked extend from 4650 to 4710. This agrees closely with the strong characteristic bright line in spectra of the fifth type. A few other stars with similar spectra have been announced in Harvard Circulars. The variable star—*Crucis*, R.A. = 12^h 50^m.7, Dec. = — 57° 21′ (1900), has a spectrum similar to that of *Z.C.* 18^h 1935, but in it the hydrogen lines *Hγ* and *Hβ* are bright, as in variables of the earlier subdivisions of class Md.

No other spectrum has yet been found on these photographs like that of *π′ Gruis*, but that of *R Cygni*, as photographed on December 2, 1890, bears a closer resemblance to it than any other spectrum yet photographed here.

Burnham's Forthcoming General Catalogue of Double Stars: EDWIN B. FROST.

With Professor Burnham's permission a brief statement is made here regarding this important undertaking, the basis for which has existed in manuscript for many years. A grant from the Carnegie Institution in 1903 made publication possible, and rather more than four fifths of the work has now been set up and electrotyped.

It includes about 13,000 double stars north of 31° south declination.

Part I. consists of a tabular catalogue, in quarto form, giving in order of right ascension the position, first measures, observer and other data, in eleven columns.

Part II. contains notes on the stars, selected measures (up to date of printing), showing motion or otherwise, present relation of the components, and references to all published measures.

This part will include some 10,000 unpublished observations made at the Yerkes Observatory in the last five years, and about as many more furnished principally by Messrs. Aitkin and Hussey of the Lick Observatory and Eric Doolittle of the Flower Observatory.

It is hoped that the work may be published during the year 1906.

Photographic Photometry of Rapidly Changing Variable Stars: J. A. Parkhurst and F. C. Jordan.

The light-curves of certain rapidly changing variables were determined from a series of short exposures on a single plate, taken with the twenty-four-inch Yerkes reflecting telescope. In order to utilize fully the advantages of the method: (1) the exposures were made short, so as not to smooth out the light-curve; (2) a number of comparison stars were used; (3) diameters of the focal images were measured to 0.001 mm. under the microscope.

The variable stars investigated by this method were:

Star.	Number of Plates.	Number of Exposures.
U Cephei,	1	20
W Ursæ Majoris,	3	35
RW Tauri,	7	55
14. 1904 Cygni,	8	53
32 Cassiopeiæ,	4	72

Results.—(1) *U Cephei.* The well-known curve was reproduced, with average residuals of ± 0.04 magnitude. (2) *W Ursæ Majoris.* The curve is similar to that drawn by Müller and Kempf; with corrections to their ephemeris for epoch 1777, $+ 2^m$; epoch 1945, $+ 13^m$. (3) *RW Tauri.* The range is $3\frac{1}{4}$ magnitudes, the most rapid change at the rate of three magnitudes per hour; the correction to Pickering's ephemeris at epoch 2598 is $+ 38^m$; epoch 2602, $+ 37^m$. (4) *14. 1904 Cygni.* The range is 0.7 magnitude, the period is $3^h\ 1^m\ 26^s.4$; the curve resembles the 'cluster type.' (5) *32 Cassiopeiæ* (suspected variable). No variation was found beyond accidental errors of measurement, the mean residuals for the four plates, each covering the greater part of the suspected period, being ± 0.05, ± 0.05, ± 0.06 and ± 0.04 magnitudes.

Spectrograms taken at Daroca, Spain, August 30, 1905 (U. S. Eclipse Expedition): S. A. Mitchell.

Five spectrographs were employed; three gratings and the other two alike having a dispersion of one weak prism. Weather conditions were perfect. Results with the two larger instruments are as follows:

1. *Parabolic grating,* diameter four inches, with 14,438 lines to the inch and a focal length of five feet. The dispersion of this instrument is about the same as the Bruce three-prism spectrograph of the Yerkes Observatory and the Mills spectrograph of the Lick Observatory. The distance from D_3 to H is almost exactly seven inches, the total length of the photographed spectrum being 9.5 inches. The definition is excellent throughout the whole length of the flash, which extends from D_3 to λ3300, and shows a very great number of lines.

The spectrum taken near mid-totality shows some interesting coronal rings. The green 'coronium' ring appears very plainly and two rings in the extreme ultra-violet are just as prominent on the photograph as the green ring. As the plate used has

a photographic action which is just as intense in the ultra violet as in the green, it would seem that the corona is very rich in ultra-violet rays. The following coronal lines are seen at approximately, λλ3381, 3388, 3455, 3643, 3984, 4228, 4565, 4618 and the 'coronium' line at λ5303.

2. *Flat Grating,* with 15,000 lines to the inch, and a ruled surface 3½ x 6 inches. The lens is a Clark five-inch visual with a focal length of about six feet. On the photographs the distance from D_3 to H is eight inches. In the flash spectrum lines can be seen beyond D toward the red almost to C. This is the end of the spectrum most desired, and the focus is excellent from F to the extreme of the red. The green (coronium) ring also appears on the plates taken near mid-totality.

Observations of Radial Velocities: EDWIN B. FROST.

The four principal programs of observations with the Bruce spectrograph of the Yerkes Observatory are: (1) standard velocity stars; (2) stars of *Orion* type; (3) visual binaries; (4) miscellaneous variable stars. About 500 plates of over 100 stars of program (2) have been measured (many in duplicate); three or more satisfactory plates have been obtained of 135 stars of the *Orion* type, and one or two plates of forty more.

It is important to secure at this epoch good determinations of the sight-line velocity component for visual binaries of program (3). With Burnham's assistance an observing list was compiled containing 120 stars known to be binary, and bright enough to be observable with the Bruce spectrograph, at least with one prism. Preference was given to pairs differing in magnitude sufficiently to prevent confusion of spectra, and for which the brighter component would have fairly sharp lines.

The writer's measurements of *P Cygni* show that the strong and broad *bright* components of the hydrogen and helium lines have only a very small displacement, corresponding to a radial velocity of about 12 km. per second of approach; while the *dark* components, sharply defined at each margin, and comparatively narrow, yield very large displacements toward the violet, differing for hydrogen and helium. If interpreted by Doppler's principle, the velocities (approach) would be about 190 km. for hydrogen and 150 km. for helium; the three blue silicon lines seem to have no bright components, and from these a consistent value of about 80 km. (approach) is derived. An attempt to account for these differences as a result of overlapping of the dark and bright lines has not yet been successful. A comparison with Belopolsky's observations of this star made in 1899 indicates that the displacements are not variable. Physical causes may be responsible for this remarkable spectrum.

Spectrograms of the variable star *R T Cygni,* obtained in conjunction with Parkhurst, when the star was of magnitude 7.5, showed bright $H\gamma$ and $H\delta$ with an exposure as short as 45 minutes. These bright lines were very strongly displaced toward the violet, corresponding to an approaching radial velocity of 100 km. per second. It now seems probable that this did not vary during the first half of December, 1905, which period included the five plates obtained.

It is possible that variations occur in the bright lines of *Pleione,* which were very weak, if present, on three plates recently obtained, although they were shown on spectrograms taken by the writer at Potsdam in 1891, and on Harvard plates. The spectrum of *α Columbæ* is peculiar, and *μ Orionis* has been found to be a spectroscopic binary.

The Solar Corona, as observed by the U. S. Naval Observatory Eclipse Expedition, August 30, 1905, at Porta Cœli, Spain: G. H. Peters.

The observing station was near the eastern coast of Spain, north of Valencia. It was located about ten miles north of the southern limit of the shadow path, for the purpose of studying especially the regions about the southern pole of the sun.

The corona at this eclipse, occurring near the sun-spot maximum, had a structure entirely different from those of 1900 and 1901. The polar rays were nearly obliterated by numerous streamers and wings, which were nearly equally prominent throughout the whole circumference. The entire corona exhibited a mass of fine details, considerably striated, and to a great extent intermingled.

Vacant Regions of the Sky: E. E. Barnard.

There are two distinct classes of these vacancies. The commonest form has all the appearance of real openings in the bedwork of stars—through which there is an uninterrupted view of space. The other class, mainly found in *Ophiuchus* and *Scorpio*, suggest the presence of a nebulous substratum among the stars. The appearance of these latter regions is widely different from ordinary vacancies, their marked features being areas devoid of stars, yet apparently filled with some other substance in which blacker holes occur, as if there were a nebulous veiling pierced with holes and rifts.

The most remarkable of these regions are those about θ and ρ *Ophiuchi*, the latter being connected with the great nebula of ρ *Ophiuchi*. From this latter region a straggling vacant lane runs easterly for a distance of some 15° and connects with a great chasm just east of θ *Ophiuchi*. Some vacancies near this latter star are very small and very curious, all showing more or less the appearance of vacancies within vacancies.

Attention is called to the probable relative smallness of stars forming the bedwork of the Milky Way near Antares. The small stars here seem to be intimately related to the great nebula of ρ *Ophiuchi*. But the nebula certainly involves such naked eye stars as ρ *Ophiuchi* and σ *Scorpii*, and appears to involve even *Antares*. Reasoning from this that the nebula, the small stars of the Milky Way, and the brighter stars here, are at relatively the same distance from us, the natural conclusion is that the apparently great difference in size between the above-named stars and the groundwork of small stars of the Milky Way at this point is not so much due to a greater distance of the smaller stars as to their being actually very much smaller.

Determination of Absolute Star Positions by Photography: E. C. Pickering.

It is proposed to determine the absolute positions of a zone of equatorial stars by means of photography. A telescope of long focus is pointed to the intersection of the equator and meridian, and motion is given to the photographic plate equal to that of the stars. Reference points are furnished by holes through which a small incandescent light shines on the plates. Current is sent from a standard clock, which should be kept underground at a uniform temperature and pressure. As observations would extend over one year at least, errors depending on the sun's position should be eliminated. The only parts of the apparatus that need be rigid are the objective and the plate carrying the reference holes. So long as the images, which have an exposure of about a minute, are sensibly circular, or uniformly elongated, slight motions of the photographic plate are unimportant. The principal advantage of this method is that stars as faint as the

tenth or eleventh magnitude may be recorded, and a large part of the entire region may be photographed in a single night. It might be better to photograph a zone a little north of the equator in midwinter, at a station so far north that observations could be made continuously during twenty-four hours. Many forms of small systematic error would thus be eliminated.

The Polaris Vertical Circle Method of Determining Time and Azimuth: F. H. SEARES.

The vertical circle method of observing for time and azimuth has been known for a century or more, is capable of affording very precise results, but has never found general acceptance on account of a lack of satisfactory methods of reduction. The most important methods have been devised by Döllen and Harzer. The formulæ of Döllen are not sufficiently accurate for many purposes; moreover, the Ephemerides necessary for the use of his formulæ are no longer published. The method of reduction proposed by Harzer lacks nothing in precision, but the calculations are unnecessarily long. Laws Observatory Bulletin No. 5 contains a method which affords the desired precision, and permits of a saving of three tenths in the labor of calculation as compared with the process of Harzer. The present paper separates the features which are essential for the practical application of the method from certain purely theoretical considerations contained in Bulletin No. 5, and is intended to exhibit more clearly the simplicity and brevity of the operations involved in the employment of the writer's formulæ.

Although it is not contended that the vertical circle method can profitably replace the older methods in all cases, the following advantages are claimed:

1. A saving in labor when it is necessary to determine both time and azimuth.

2. A gain in precision and a saving in labor in the determination of time with unstable instruments, especially when it is desirable to secure all possible accuracy.

3. A frequent saving in time and labor, irrespective of whether the instrument be stable or unstable, when it is necessary to work through clouds.

4. When applied to the engineer's transit, it affords a very simple and precise method of determining time in the field, and frees the observer from any necessity of waiting for an elongation of Polaris in order to secure observations for azimuth.

Determination of Adjustment Errors for the Polar Axis of an Equatorial: ERIC DOOLITTLE.

The method consists in measuring the position angle of a pair of stars close to the pole. Each measure gives an equation for determining the position angle, supposed unknown, and the instrumental errors. From several measures at different hour angles the latter can be determined with a degree of accuracy probably higher than by any method in which the circles of the instrument are used. The ordinary formulæ must, however, be considerably modified for this purpose.

Two determinations of the error of adjustment for the 18-inch equatorial belonging to the Flower Observatory were made, the results agreeing within 1 second, and the probable error of each result being less than 1.5 seconds.

The advantages of the method are that observations are very easily made, that there is no moving of the dome or observing chair, and that the time need only be known very roughly. The setting circles are not read, and hence their errors of graduation do not affect the result. The disadvantage is that the subsequent labor of reducing

positions of polar stars to apparent place is so great as to preclude the method becoming of much practical value.

The Hough Double Stars: Eric Doolittle.

Work on the 622 double stars discovered by Hough has been carried on, only about 50 of them now remaining unmeasured. It is hoped that these may be finished during the present year.

The Observations of Sun-spots by the Late C. H. F. Peters: Edwin B. Frost.

It has been for many years a matter of regret to students of the sun that the solar observations by this careful observer have remained inaccessible. In 1904 the Carnegie Institution decided to publish them, and the writer was requested to edit them.

The observations cover the decade from May, 1860, to May, 1870, with some interruptions, and more than 13,000 heliographic positions of spots were accurately determined on over 1,100 days. The first year's observations overlap the last year of Carrington's series, and Spoerer's observations at Anclam extend from 1861 to 1871. While it is thus decidedly unfortunate that Peters's results could not have been published thirty-five years ago, their value for comparative purposes is still great, and they were obtained with better instrumental equipment than the other two contemporary series.

The manuscript was supposed to have been left by Dr. Peters in a condition for printing, but some abridgment of the tabular data has now seemed desirable. No manuscript has been found describing the method of observation or procedure used in obtaining the constants of reduction, which constants in fact have to be inferred. The galley proofs of the tabular part have now been read, and it is hoped that the volume can be issued during 1906.

Computed Tracks and Totality-durations of Total Solar Eclipses in the Twentieth Century: David Todd and Robert H. Baker.

Their tracks of visibility have been calculated and charted as accurately as possible. This has been done from Oppolzer's tables (*Canon der Finsternisse*), the most reliable at present in existence, and Oppolzer's own charts corrected. The longest eclipses of the next half-century are:

1911, April 28,	duration 5½	minutes.
1919, May 29,	duration 7	minutes.
1922, September 21,	duration 6½	minutes.
1923, September 10,	duration 4	minutes.
1926, January 14,	duration 4½	minutes.
1929, May 9,	duration 5½	minutes.
1937, June 8,	duration 7½	minutes.
1940, October 1,	duration 6	minutes.
1944, January 25,	duration 4½	minutes.
1947, May 20,	duration 5½	minutes.
1955, June 20,	duration 7½	minutes.

An Analytical Method of Determining Orbits of New Satellites: A. O. Leuschner.

This paper contains formulæ for the computation of osculating elements of a material point moving under the attraction of more than one mass, from three or more geocentric observations. It is applicable to satellites, comets or asteroids which are greatly disturbed during the time over which the observations available for the computation of an orbit extend. The resulting osculating elements are the elements that would result from a solution irrespective of the perturbations if the observed right ascensions and declinations of the material point could be corrected in advance for the perturbations, starting with an arbitrary epoch of osculation within the range of the observations. As in the short method proposed by the writer for deriving orbits of comets and asteroids, the right ascension (α) and declination (δ), their velocities (α', δ'), and accelerations (α'', δ''),

are determined empirically for the date of an observation near the middle of the available data. Being accurately determined from the disturbed geocentric coordinates, these six quantities correspond to the osculating elements.

In the case of a distant satellite of Jupiter disturbed by the sun, let be:

$\rho, \alpha, \delta, \sigma = \rho \cos \delta, \xi, \eta, \zeta$ = geocentric coordinates of the satellite.

$r, a, b, s = r \cos b, x, y, z$ = Jovicentric coordinates of the satellite.

$[r], [a], [b], [s] = [r] \cos [b], [x], [y], [z]$ = heliocentric coordinates of the satellite.

$(\rho), (\alpha), (\delta), (\sigma) = (\rho) \cos (\delta), (\xi), (\eta), (\zeta)$ = geocentric coordinates of Jupiter.

$(r), (a), (b), (s) = (r) \cos (b), (x), (y), (z)$ = heliocentric coordinates of Jupiter.

$R, A, D, S = R \cos D, X, Y, Z$ = geocentric coordinates of the sun.

$(k)^2 = mk^2$, where m = mass of Jupiter.

Then from the equation of motion of the satellite referred to Jupiter's center as origin:

$$\frac{d^2x}{dt^2} + (k)^2 \frac{x}{r^3} = -k^2 \left\{ \frac{[x]}{[r]^3} - \frac{(x)}{(r)^3} \right\},$$

and the corresponding equations in y and z, three equations are deduced which give ρ, ρ', ρ'', in terms of known coordinates, velocities and accelerations, and in terms of the unknowns (r) and $[r]$. The complete expression for ρ is

$$\rho = \frac{A}{r^3} + \frac{B}{[r]^3} + C,$$

A, B and C being expressed, as indicated above, in terms of known quantities. The solution of this equation together with the equations

$$[r]^2 = R^2 + \rho^2 - 2R\rho \cos [\psi]$$
$$r^2 = (\rho)^2 + \rho^2 - 2(\rho)\rho \cos (\psi)$$

gives all the values of ρ corresponding to the various possible solutions. In practise, the solution of these equations is very simple. From ρ the value of ρ' is derived. The remaining steps leading to the osculating elements are similar to those of the short method. The short method, itself, is a special case of that under discussion, terms depending upon the mass of Jupiter dropping out and the motion being referred to the center of the sun.

Among other special cases of this analytical method is that obtained by omitting the terms depending upon the solar attraction in these formulæ. The resulting formulæ will then be those for the determination of the undisturbed motion of the satellite. The general method is applicable to material points moving under the attraction of any number of masses. The method presents the advantage that it is free from all arbitrary assumptions, whether introduced with the assistance of graphical construction or otherwise, and that it reveals all possible sets of osculating elements which will represent the disturbed geocentric positions given by observation.

Planetary Inversion: WILLIAM H. PICKERING.

This paper was illustrated with a gyroscope. The subject has already been treated theoretically in other places, and the present paper is therefore purely experimental. The gyroscope was arranged so that it could turn about an axis passing through the plane of the wheel, and also about a vertical shaft which supported it.

According to the nebular hypothesis, when the rings or spirals surrounding a central sun broke up into planets, each planet should, by Kepler's third law, have a retrograde rotation. The fact that nearly all planets rotate in the opposite direction has always been held a serious objection to the hypothesis, and several different suggestions have been offered to explain the discrepancy. None of these even attempted, however, to explain the rotation of Uranus, which lies in a plane practically at right angles to the orbit.

The gyroscope was set spinning in a

retrograde direction. The stand which supported it was then held by the speaker at arm's length, while he gave himself a slow direct rotation upon his feet, thus imitating the motion of a retrograde planet in its orbit. By applying friction to the vertical shaft, and thus introducing the effect of an annual tide upon a planet, it was shown that the gyroscope would slowly shift its plane of motion. Its equator first became inclined to the orbit, like that of Neptune, and later nearly at right angles to it like that of Uranus. The shifting of the plane of rotation continuing in the same direction, the rotation itself now became direct, and its plane gradually approached that of the orbit. The inclination was before long the same as that of Saturn, and later the same as that of Jupiter. The two planes now practically coincided, and the rotation and revolution were in the same direction.

When this became the case the plane of rotation had reached a position of stable equilibrium, unaffected further by tidal action. Reversing the direction of orbital motion again shifted the plane of rotation, which now also became retrograde, showing that the phenomenon exhibited was a real property of the gyroscope, as had indeed been proved theoretically, and was not an effect due to some faulty construction of this particular instrument.

Tables for the Reduction of Photographic Measures: Burt L. Newkirk.

These tables are intended to facilitate the transformation from standard rectangular coordinates to differences of right ascension and declination as well as the converse transformation, and the correction for refraction, including terms higher than the first order in the measured coordinates. Being intended primarily for use in the reduction of plates made with certain lenses belonging to the Berkeley Astronomical Department, which cover a field some ten degrees in diameter, they are applicable to stars whose right ascensions differ from that of the center of the plate by ten degrees or less and whose declinations differ from that of the center of the plate by five degrees or less, no matter what the declination of the center of the plate may be.

The tables for the transformation of standard rectangular coordinates into intervals of right ascension and declination and its converse are based upon Professor Turner's fundamental relations:

$$\eta = \tan (d - \delta_0)$$
$$\tan d = \tan \delta \sec (\alpha - \alpha_0)$$
$$\xi \sec d = \frac{\tan (\alpha - \alpha_0)}{\cos (d - \delta_0)}$$

Three tables have been constructed, giving quantities A, B, C, such that, given:

$$\alpha_0,\ \delta_0,\ \xi,\ \eta,$$
$$d - \delta_0 = k\eta - A,$$
$$\alpha - \alpha_0 = k\xi \sec \delta - C,$$
$$d - \delta = B,$$

giving:

$$\delta - \delta_0 = d - \delta_0 - (d - \delta),$$

or, given:

$$\alpha_0,\ \delta_0,\ \alpha,\ \delta,$$
$$d - \delta = B,$$
$$k\eta = d - \delta_0 + A,$$
$$k\xi \sec d = (\alpha - \alpha_0) + C.$$

In which

α_0, δ_0 = coordinates of center of plate;
α, δ = coordinates of star;
ξ, η = standard coordinates of star;
k = scale value factor.

The tables for the determination of the refraction correction are also based upon formulas of Professor Turner:

$$\Delta x = (X - x)\, t,$$
$$\Delta y = (Y - y)\, t,$$
$$t = \mu \frac{1 + x^2 + y^2}{1 + xX + yY}$$

In which

X, Y } = true coordinates of zenith and star projected on plate;
x, y }

Δx } = projections on plate of *total* displacement of star due to refraction;
Δy }

μ = refraction constant.

The tables are so constructed that the terms of Δx and Δy, which represent the displacement common to the star and the center of the plate, have been omitted. Those terms of Δx which are proportional to x and the terms of Δy which are proportional to y have also been omitted, these corrections being automatically applied in the determination of the plate constants.

A Contribution on Astronomical Refraction: RUSSELL TRACY CRAWFORD.

An investigation of the constant of refraction was made in the year 1899 which resulted in the discovery that this so-called constant is a function of the zenith distance. The observations were made with the Repsold meridian circle of the Lick Observatory and reduced by a method which is the converse of Talcott's method of determining latitude.

This method has both its advantages and disadvantages. Among the former, the most important are: first, total elimination of the latitude, and hence also of its variation; second, elimination of the nadir reading; third, there is no wait of twelve hours or six months in order to observe a star at both culminations; fourth, only one half of any error of observation or in the declinations used enters into the reductions; and, finally, the simplicity of the observations.

The greatest disadvantage lies in the fact that the declinations have to be considered known. But by taking fundamental stars, such as those of Professor Newcomb's new 'Fundamental Catalogue,' and by taking a large number of these stars, this difficulty will be nearly completely eliminated.

Two independent series of observations were made for this investigation. One was made during the summer months, giving

$$\Delta \log \mu = 0.000101\ (56°.6 - z).$$

The other made during the winter months gives

$$\Delta \log \mu = 0.000117\ (59°.3 - z).$$

Combining these into one solution, the two constants of the expression become

$$+ 0.000108 \pm 0.000010 \quad \text{and} \quad 58° \pm 8°,$$

so that the Pulkowa tables should be corrected by

$$\Delta \log \mu = 0.000108\ (58° - z)$$

where z is the zenith distance in degrees.

The efficiency of tables constructed by applying this correction to the Pulkowa tables may be shown by comparing a series of observations reduced by the two. In his preliminary reductions of his observations of the Piazzi southern stars, Tucker has used the Pulkowa refractions. In his final reductions, he has corrected his declinations for errors in refraction which are given as a function of the zenith distance. Auwers has published further corrections to reduce Tucker's results to his fundamental system (*Abhdlg. z. d. A. N.*, No. 7). The differences between the corrections Auwers + Tucker and those resulting from this investigation are less than the probable errors of observations found by Tucker.

A Solar Planisphere: SARAH F. WHITING.

In connection with the students' laboratory work at Whitin Observatory, Wellesley College, a device for working problems in relation to the hours of day, night and twilight, at different latitudes at different times of year, has lately been worked out chiefly by E. Rebecca Ellis, assistant. We do not find this simple contrivance, which we call a solar planisphere, elsewhere described.

Using a stiff card, the sphere is projected on the plane of the meridian. The horizon and twilight circles eighteen degrees below are also drawn. Upon another smaller circular card, pivoted to the first at its center, the six-o'clock hour-circles through the poles, the equator, and diurnal paths of the sun at the solstices are projected in straight lines. Harmonic projections of the hour-circles for every twenty minutes are marked on these.

By revolving the movable card the pole can be set to the proper elevation for any latitude, and the number of hours of darkness, twilight and daylight can be read. The time of sunrise and sunset and the meridian altitude of the sun at noon or midnight can also be measured.

These fundamental phenomena should be made clear even in preparatory schools, but from our observation of college students it is evident they are not. To put such a piece of apparatus into the hands of each student, with which he can solve a set of problems, would be another move in the direction of individual laboratory work in general astronomy which it seems so difficult to secure.

The model has been entrusted to the Arthur Hall Scientific Company, of Boston, for reproduction, in the hope that it may be of service.

The Repsold Measuring Apparatus of the Students' Observatory, Berkeley, Cal.: Burt L. Newkirk.

This paper contains an investigation of the instrument, with a determination of corrections which must be applied to measures made with it. The method employed in measuring division errors of the scales is essentially the one employed by Gill for the scales of the Cape heliometer and Repsold measuring apparatus. Corrections are determined for each line of the X scale and for seventy lines (from line 230 to line 300) of the Y scale. The corrections are given to ten-thousandths of a millimeter and are accurate to within a few units of the last place.

The irregularities of the X micrometer throughout three revolutions have been investigated and a table of the corresponding corrections determined by the method outlined in Brünnow's 'Spherical Astronomy,' p. 426, fourth German edition. Two independent determinations yield results differing by about .0003 mm. in the maximum.

The straightness of the cylinder which determines the Y axis and of the bar which determines the X axis was also tested, as well as the perpendicularity of the directions of these two parts of the apparatus. The cylinder and bar were found to be very satisfactory and their directions are made perpendicular by adjustment.

The measurement of the distance between two well-defined points on a plate, first as a difference of X coordinates and then as a difference of Y coordinates, yields results differing by slightly more than the error of measurement, indicating that the Y scale is not exactly parallel to the plate. The maladjustment in this particular would introduce an error into the measures that would in general be entirely negligible.

Tables are added for applying the necessary corrections to measured coordinates.

The Forty-foot Camera of the U. S. Naval Observatory Eclipse Station at Guelma, Africa: W. W. Dinwiddie.

This instrument was mounted horizontally and the light was led to it by the mirror of a Gaertner cœlostat. Three ventilating doors were made in the lower side of the forty-foot tube, which, operated in connection with the trap doors in the roof of the building at the plate end of the tube, gave perfect ventilation and kept the whole instrument cool.

The shutter used in making the exposures

during totality was placed in a nearly horizontal position above the mirror, and not between the lens and mirror, as is customary. The sunshade over the building and tube, and the wall of the tube, which was on the opposite side from the sunshade, were all whitewashed with ordinary lime. The sunshade was of opaque black cloth, and all the inner surfaces were black.

At the time of the eclipse eight exposures were made as follows: 2^s, $5^s.2$, $13^s.2$, $1^m28^s.1$, $38^s.3$, $6^s.8$, 5^s and an exposure of one fourth second about ten seconds after third contact. All the negatives are sharp and clean. The unusual completeness of the series gives every part of the corona in fine detail on one or more of the plates. The first exposure shows a very large group of prominences. The short exposure made after the reappearance of the sun shows the entire ring of the corona. On this plate the prominences on the bright limb are shown in fine detail, and from it good measures may be made of the height of the chromosphere.

The first and fourth contacts were observed visually from the image on the face of the focal plane shutter, and recorded by a stop-watch. I think that this method of observing the outer contacts has advantages over the ordinary method of observing the limb with a small telescope. The times of the exposures were marked on the chronograph by a key operated by an assistant who looked after the cœlostat clock, set the mirror, etc.

The plates were thoroughly backed with water-color lampblack, which was carefully wiped off before development. Distilled water was used in developing and fixing, and after washing, the plates were rinsed in distilled water.

Polarized Coronal Light, August 30, 1905: C. D. PERRINE.

Observations of polarized light in the corona were made by the Lick Observatory-Crocker Eclipse expedition to Alhama, Spain. A double-image prism was used in connection with a camera of twenty and three fourths inches focal length, in continuation of the work at Sumatra in 1901.

More efficient apparatus was designed for the recent eclipse, and plane glass mirrors were used as analyzers. These cameras were of fifty inches focal length and yielded sharp images of good scale for photometric measurement. Strong radial polarization is shown on all the negatives.

Anomalous Refraction: FRANK SCHLESINGER and C. B. BLAIR.

Under ordinary circumstances the atmosphere is disposed in horizontal strata of uniform density; but these strata may be inclined occasionally to the earth's surface, giving rise to anomalous refraction.

In this case the usual expression for refraction should be replaced by a somewhat different one, deduced by the writer. The new formula has been applied to observations made in 1900 and 1901 at the six international latitude stations, with the object of discovering whether the effect of anomalous refraction is large enough to justify the frequent, but vague, appeals which have been made to this source of error in order to account for inconsistencies in meridian work. From this discussion it appears that observers have little to fear from this cause.

An important corollary to this conclusion relates to Kimura's recently discovered term in the latitude variation, independent of longitude. The present paper makes it highly probable that this phenomenon has a real existence and is not due, as has been suggested, to anomalous refraction.

New Variable Stars in the Small Magellanic Clouds: HENRIETTA S. LEAVITT.

At the meeting of the Astronomical and Astrophysical Society held in Philadelphia

in December, 1904, a brief account was given by the writer of methods and results in a study of faint variable stars recently undertaken at Harvard College Observatory. The most remarkable regions as yet examined are the Nebula of Orion and the two Magellanic clouds. These were mentioned a year ago, when it was reported that the numbers of variables in the large and the small Magellanic clouds were one hundred and fifty-two and fifty-seven, respectively. In the autumn of 1904, a series of sixteen plates was taken at Arequipa, covering the region of the small Magellanic cloud. These arrived at Cambridge in February and were examined with great interest, as it was expected that the number of variables would be considerably increased. The result of the examination, however, exceeded all anticipations. So many were found that it was April before the preliminary study of the plates was completed and it could be announced that nine hundred new variables had been discovered. The number has since been increased to nine hundred and seventy, and new ones are still being discovered from time to time. Measurements of the positions of all these, selection and measurement of a large number of sequences of comparison stars, and the determination of a provisional light-scale, have necessarily consumed much time, so that it is only within a few weeks that it has become possible to begin actual observation of the brightness of the variables. Light-curves thus far deduced are of well-defined types. Periods of many of the variables appear to range from one and a quarter to four days. A number, mainly among the brighter ones, have periods of from one to two weeks, while very few appear to have long periods. A preliminary examination of recent photographs of the large Magellanic cloud shows that it resembles the region now under discussion and it is probable that a very large number of variables will be found to exist within its limits. Preparations for measuring the positions and brightness of these are already being made.

The question as to whether there are other regions containing such remarkable groups of variable stars, is of the greatest interest. Not less important is the general problem of the distribution of these fainter variables. An exploration of new regions, therefore, is being undertaken as time permits, and even negative results, though less immediately interesting, are valuable as a contribution toward an ultimate solution of the problem.

Amherst Eclipse Expedition to Tripoli, 1905: David Todd.

Instruments installed on the rigid roof-terrace of the British Consulate-General. Six departments of observation:

1. Observations of the geometric contacts.

2. Coronal photography with a twelve-inch Clacey lens of nine feet focus, photographically corrected. Eighteen exposures with semi-automatic movements. Baily's beads also photographed before second contact. My modified form of Burckhalter revolving occulter was employed on the corona. Corona photographed to 30′.

3. Duplex Clark lenses (photographic) of three inches aperture and eleven feet focal length, for long exposures on the circum-solar stars and the outer coronal streamers. No intra-mercurial planet revealed on 14 x 17 plates of the highest sensitiveness, stars to seventh and eighth magnitude.

4. A three-and-one-half-inch Goerz doublet of thirty-three and one half inches focus, attached to one of the automatic movements used on my previous expeditions of 1896, 1900 and 1901, secured 63 fine pictures of the corona during the 186

seconds of totality. Some of these show the coronal streamers to exceptional length.

5. Sketches of the corona with usual results.

6. Observations of shadow bands begun at least ten minutes prior to totality: bands wavering and narrow, moving swifter than one could walk, at right angles to the wind, their length with it, and waxing and waning five times during the interval of observation preceding totality. These observations communicated in detail to Mr. Lawrence Rotch of the Blue Hill Observatory. Other results in the *Astrophysical Journal.*

The Philadelphia Observatory: MONROE B. SNYDER.

The Philadelphia Observatory, an outgrowth of the old Central High School Observatory (1837–1900), was planned by the writer for an astrophysical observatory to begin with the twentieth century. The plan included a city station, chiefly for solar work and necessary popular instruction, and a suburban station, not yet realized, where certain lines of celestial photography could be undertaken. Peculiar difficulties delayed completion of the building and equipment, and there was a marked absence of financial and other support for the scientific work, so that not until early in 1905 was the really superb equipment, designed for both stations, received, and, as far as possible, erected at the city station in the new building of the Philadelphia Central High School.

On March 9, 1905, a destructive fire (probably originating in a combination gas and electric-light fixture), and long feared by the director of the observatory and others on account of municipal neglect of the usual fire precautions, swept the tower and destroyed an equipment and astronomical library valued at approximately $55,000, and produced a loss in equipment and building of more than $100,000. The equipment destroyed represented in a number of respects the very best attainable in instruments of moderate size, and included: A fifteen-inch refractor with Warner and Swasey mounting, the finest for its size, and provided with both a visual objective and a photographic objective of excellent definition, by Brashear; a Wadsworth-Hale spectroheliograph designed to photograph the sun in three different wavelengths simultaneously; a large Keeler spectroscope and spectrograph, attached to the telescope on the day of the fire for the purpose of rediscovering (during maximum solar activity) Hale's disturbance in the sun's spectrum; a Warner and Swasey filar micrometer; a four-inch portable transit instrument with the writer's electrical transiter attached; clocks and chronographs (partially destroyed); a five-inch Rowland concave grating finely mounted by Brashear; a goodly equipped mechanical shop and photographic laboratory; and many smaller but valuable physical appliances.

The loss of a carefully selected library of some four thousand volumes representing the chief periodicals and literature in astronomy and astrophysics almost completed the destruction of years of effort. An eight-inch refractor and an unmounted set of Brashear eight-inch curved plate star cameras were rescued.

The main purpose, under the conditions of work hitherto allotted, was not only that the equipment should as a whole express the best current science, but that certain instruments like the spectroheliograph and its method of operation, the transiter, the new form of Hough printing chronograph, and the large curved plate star cameras should represent distinct advances in observatory equipment.

The observatory is in process of reconstruction.

Orbit of the Seventh Satellite of Jupiter: R. T. CRAWFORD and A. J. CHAMPREUX.

This paper gives results of an application of Leuschner's 'Analytical Method of Determining the Orbits of New Satellites.' Three solutions were made which are designated in the tabulation given below by (Cr. & Ch.)$_1$, (Cr. & Ch.)$_2$ and (Cr. & Ch.)$_3$. The orbits are based on Perrine's positions of January 3, February 8 and March 6, 1905. The first set of elements was derived irrespective of any perturbations. The second represents the first approximation to elements osculating February 8 by taking immediate account of the attraction of the sun. The third set is the result of a close representation of the observations on the same basis. For comparison, the elements by Perrine (L. O. Bulletin No. 78) and by Ross (L. O. Bulletin No. 82) are also tabulated. The first set of elements does not represent an observation of August 9 any better than those by Ross. The third set, however, gives the residuals $(O - C)$:

$$\Delta p = +2°.7$$
$$\Delta s = +5'.2$$

the computed positions being derived directly from the third set of elements osculating for February 8 without applying the solar perturbations February 8 to August 9. The solar perturbations are being computed for all observations secured since the discovery observations, by an adaptation of Encke's method of special perturbations in rectangular coordinates. With these perturbations it is expected to represent recent observations closely. Outstanding differences will serve to correct the third set of elements. With each of the three sets, a second solution with retrograde motion was obtained.

HAROLD JACOBY.

ELEMENTS OF THE SEVENTH SATELLITE OF JUPITER (DIRECT MOTION) REFERRED TO THE EARTH'S EQUATOR.

Computer.	Ω	i	ω	e	Period.	a
					d	
(Cr. & Ch.)$_1$	279° 45′ 8″	26° 27′ 14″	006° 28′ 42″	0.12576	251.1415	49′ 48″
(Cr. & Ch.)$_2$	289 47 45	25 39 42	189 15 19	0.13195	255.5376	50 20
(Cr. & Ch.)$_3$	288 19 59	25 39 23	187 29 41	0.12152	258.9424	50 47
Perrine (prel.)	275 47	26 15	182 6	0.24	200	43 48
Ross (final)	281 7.8	26 12	331 16.8	0.0246	265.0	52.54

a (Cr. & Ch.) for log $(\rho) = 0.72124$; a (Ross) for log $(\rho) = 0.71624$.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. SECTION A—MATHEMATICS AND ASTRONOMY.

Vice-president—W. S. Eichelberger, United States Naval Observatory, Washington, D. C. In the absence of the vice-president, Professor Alexander Ziwet, the retiring vice-president, presided at the meetings of the section.

Secretary—Professor L. G. Weld, State University of Iowa, Iowa City, Iowa.

Member of the Council—President C. S. Howe, Case School of Applied Science, Cleveland, Ohio.

Sectional Committee—Dr. W. S. Eichelberger, vice-president, 1906; Professor Alexander Ziwet, vice-president, 1905; Professor L. G. Weld, secretary, 1904–1908; Professor J. R. Eastman, one year; Professor Ormond Stone, two years; Professor E. B. Frost, three years; Professor E. O. Lovett, four years; Professor Harris Hancock, five years.

Members of the General Committee—Professor G. B. Halsted.

Press Secretary—The secretary of the section.

Dr. Edward Kasner, of Columbia University, was elected vice-president for the year 1907.

The address of the retiring vice-president, Professor Ziwet, on 'The Relation of Mechanics to Physics,' was presented on the afternoon of December 29, in the general assembly room in Gibson Hall, Tulane

University. This address has already been published in SCIENCE for January 12 of the current year.

At the regular program meeting of the section, held on the morning of December 30, the following papers were presented:

On the groups of Order $p^{mn}q$ having Abelian Subgroups $H_{p^{mn}}$ of Type $(n, n, \cdots, n)$: Dr. O. F. GLENN, Drury College, Springfield, Mo.

This paper is supplementary to one presented by the author at the Philadelphia meeting of the association, in which the case $n=1$ was discussed. The defining relations of all groups described in the title are tabulated, and their properties discussed in relation to the properties of the Galois field $GF[p^{mn}]$ determined by the automorph of the subgroup H. It is found that all of the groups in question are members of a general family and have one general set of defining relations.

A New Straight in non-Euclidean Geometry: Professor G. B. HALSTED, Kenyon College, Gambier, O.

The paper sets forth the discovery that, in Riemannean non-Euclidean geometry, the six mid-points of the parts of the six rays from the vertices of any triangle obtained by prolonging the sides, are co-straight. This is a new and noteworthy straight associated with every triangle.

The theorem is demonstrated, and then interpreted in ordinary Euclidean space.

A Chapter in the Present State of Development of the Elliptic Functions: Professor HARRIS HANCOCK, University of Cincinnati, Cincinnati, O.

The paper is an attempt to show that practically all (American and European) writers on the elliptic functions have been giving too much emphasis to certain parts of Weierstrass's theory, while they have neglected many of the lines of thought which Weierstrass himself considered fundamental.

It is shown that the so-called Weierstrassean normal-form is not due to Weierstrass. The introduction of new functions gives a different aspect to the presentation of the elliptic functions, although little that is new has been added thereby to the theory itself. Weierstrass's great work lies in a somewhat different direction; with him the problem of determining all analytical functions which have algebraic addition-theorems is the leading idea.

The paper also brings into evidence several fundamental theorems of Hermite and shows some of the characteristics of Riemann's theory.

A Catalogue of 1,607 Zodiacal Stars for the Epochs 1900 and 1920, Reduced to an Absolute System: Mr. H. B. HEDRICK, U. S. Naval Observatory, Washington, D. C.

This catalogue was prepared by the writer, in the Nautical Almanac Office, in order to fill the widely felt need of more fundamental positions of stars within the zodiac.

In its construction fifty-two observational catalogues were used. Systematic corrections were applied to each catalogue to reduce it to the same absolute system as that of the 'Catalogue of Fundamental Stars,' by Professor Simon Newcomb, published in the 'Astronomical Papers of the American Ephemeris,' Volume 8, Part 2.

Definitive positions were obtained by least square solutions of all the observations of each star. Right ascensions, declinations, variations and proper motions are given for two epochs, 1900 and 1920. Other features are the reference numbers to well-known catalogues, the Besselian star constants for 1910 for each star, and an index of stars by letter and constellation or by a special name.

This paper will be printed in the 'Astronomical Papers of the American Ephemeris,' Vol. VIII., Pt. 3.

A Class of Central Forces: Dr. Edward Kasner, Columbia University, New York City.

There exists no field of force in which a particle started from an arbitrary position with arbitrary velocity will describe a circular path. In the case of a central force the only possible circular trajectories are, in general, those whose centers are at the origin of force. If, however, the force varies according to a function of the form $br(r^2 - a)^{-3}$, then a quadruple infinity of the trajectories are circular. In the simplest case, arising when a vanishes, the force varies inversely as the fifth power of the distance, and the circles all pass through the origin. In the general case they are orthogonal or diametral to a fixed sphere.

Solar Photographs: Professor F. H. Loud, Colorado College, Colorado Springs, Colo. Presented by title.

The Groups of Order p^m which contain Exactly p Cyclic Subgroups of Order p^a: Professor G. A. Miller, Stanford University, Cal.

The main theorems proved in this paper may be stated as follows: If a group of order p^m, p being any odd prime, contains exactly p cyclic subgroups of order p^a, $a > 2$, it contains exactly p cyclic subgroups of every order which exceeds p and divides p^{m-1}. Hence it is one of the two non-cyclic groups of order p^m which contain operators of order p^{m-1}. When $a = 2$ and $p > 3$ the theorem is still true. In fact, the only possible exception occurs when $a = 2$, $p = 3$ and $m = 4$. In this special case there are three groups which contain exactly p cyclic subgroups of order p^a.

When $p = 2$ the preceding theorem is replaced by the following: If a group of order 2^m contains exactly two cyclic subgroups of order 2^a, $a > 2$ it can not contain more than two cyclic subgroups of any higher order. If a group of order 2^m contains exactly two cyclic subgroups of order 2^β but does not contain any cyclic subgroup of order $2^{\beta+1}$, then m can not exceed $2^{\beta+2}$. These theorems involve the fundamental properties of all possible groups whose order is a power of any prime p and which involve exactly p cyclic subgroups of any given order p^a. From a well known theorem it follows that a is not unity, but it can have every other possible value less than m.

Inversion and Inversors: Professor J. J. Quinn, Warren, Pa.

In this paper are presented two new theorems relating to inversion, besides an explanation of the construction of certain linkages exhibiting the operation of inversion.

Observations of the Total Solar Eclipse of 1905, August 30, at Tripoli, Barbary: Professor David Todd, Amherst College, Amherst, Mass.

Observations were undertaken under six different heads, as follows:

1. Observations of the geometric contacts.

2. Coronal photography with a twelve-inch Clacey lens photographically corrected. Professor Todd's modified form of Burckhalter revolving occulter was employed. The corona was photographed to 30′. Bailey's 'beads' were also photographed before the second contact.

3. A duplex Clark lens of three inches was used for long exposures on the circumsolar stars and the outer coronal streamers. Neither these nor any intra-Mercurial planets were revealed, although 14 x 17 plates of the highest sensitiveness were used.

4. With a three-and-one-half-inch Goerz doublet of thirty-three and one half inches focus (used during the previous expeditions of 1896, 1900 and 1901), attached to one of the automatic movements, sixty-three fine pictures of the corona were secured during the 186 seconds of totality. Some of these show the coronal streamers to exceptional length.

5. Sketches of the corona were made with the usual results.

6. Observations of the shadow bands were begun at least ten minutes prior to totality. The bands were wavering and narrow, moving faster than one could walk and at right angles to the wind, their length with it. They were observed to wax and wane five times during the interval of observation preceding totality. These observations have been communicated in detail to Mr. Lawrence Rotch, of Blue Hill and embodied in his exhaustive study of this phenomenon.

Computed Traces and Totality-Durations of the Total Solar Eclipses of the Twentieth Century: Professor DAVID TODD and R. H. BAKER, Amherst College, Amherst, Mass. Read by title.

A Possible Extension of the Theory of Envelopes: Professor L. G. WELD, State University of Iowa, Iowa City, Ia.

(*a*) In the equation $f(x, y, a) = 0$, representing a family of loci, by giving to a, first an increment and then a corresponding decrement, each of magnitude Δa, solving the resulting equations for the coordinates of the point of intersection and, finally, letting $\Delta a \doteq 0$, there will be obtained

$$x' = \phi(a), \quad y' = \psi(a).$$

These equations define a point of the envelope of the given family of loci and eliminating a between them gives

$$F(x', y') = 0,$$

the equation of the envelope.

The point (x', y'), determined as above, may be called the tracing point of the locus, that is, the point which, for the moment, is tracing the envelope. It was shown in the paper, by way of illustration, that the tracing point for the envelope of the family of ellipses,

$$\frac{x^2}{a^2} + \frac{y^2}{\beta^2} = 1, \quad a + \beta = c,$$

is the Fagnagni point.

(*b*) The inverse of the above notion was next developed with reference to the right line, viz.: A point on the line

$$\frac{x}{a} + \frac{y}{\beta} = 1,$$

being assigned at will, to find the functional relation between the intercepts,

$$\Phi(a, \beta) = 0$$

(*i. e.*, the law governing the motion of the line), in order that the given point may trace an envelope and, finally, to obtain the equation of the envelope. The required relation is given by either of the differential equations,

$$x' = \phi(a, \beta) = \frac{a^2}{a - \beta \dfrac{da}{d\beta}}, \quad y' = \Psi(a, \beta) = \frac{\beta^2}{\beta - a \dfrac{d\beta}{da}}.$$

In general both equations will be needed in order to determine the constants of integration. Having thus obtained the function Φ, which is, in effect, the tangential equation of the envelope, the equation in rectangular coordinates readily follows.

Several examples applying the principles were presented and its application to other families of loci was suggested as a promising field of investigation for the amateur mathematician.

LAENAS GIFFORD WELD,
Secretary.

SCIENTIFIC BOOKS.

Die Schule der Chemie. Erste Einführung in die Chemie für Jedermann. Von WILHELM OSWALD. Zweiter Teil. Die Chemie der wichtigsten Elemente und Verbindungen. Braunschweig, Friedrich Vieweg und Sohn. 1904. Price, bound, 8 Marks.

This little book will be of service to two classes of people: to schoolboys of ten to fifteen years, for whom it was primarily intended, and to teachers. It is doubtful if the average American schoolboy would be attracted by the method of presentation, even in an English translation, though it would be an interesting experiment to try and we should be glad to hear of the results. But every teacher will find the book worthy of a most careful reading. Professor Ostwald has selected with very great care that material which appears to him most fundamental and most interesting for the beginner in chemistry and he has secured a clearness and accuracy in presentation which deserve very high praise. In both directions teachers will find here a mine of useful suggestions.

The author follows, of course, his well-known attitude toward the atomic theory. He is too good a teacher not to recognize and make use of the 'hypothesis' for didactic purposes, but he evidently does this because of the hardness of chemists' hearts and wishes he could escape the necessity. This dislike for the theory sometimes betrays him into inaccurate statements or false reasoning. Thus on page 38 he explains that the formula of sulphuric acid is written with two combining weights of hydrogen, because otherwise we should have to write $HS_{\frac{1}{2}}O_2$ and 'the rule has been laid down that fractions of combining weights shall never be written.' He neither gives a reason for such an arbitrary rule nor does he explain why a combining weight of 16 might not be given to sulphur and the formula written HSO_2. It is not, of course, essential that these matters should have been explained at this point, but so misleading a reason should not have been given.

On page 42, in answer to the question, 'Are not the atoms, then, just as certain as the natural laws?' the author replies, 'Not at all, for natural laws are not based on an arbitrary assumption, as is the atomic hypothesis, but they express definite relations between quantities which can be measured and proved.' In this statement he appears to overlook the fact that the natural laws are all based on two assumptions: first, that phenomena repeat themselves with absolute uniformity under the same conditions and, second, that simple relations exist between the quantities which we measure. Each of these assumptions is arbitrary and neither can be proved. They differ from the assumptions which lie at the basis of the atomic theory in being more simple but not in their fundamental nature. To illustrate: We believe in the law that the atomic heats of the elements are equal because many similar simple relations have been found and we assume that a simple relation exists here also, though we can not prove it and are well aware that the deviations from the law are very far in excess of the experimental errors in the measurement of the quantities involved. The assumption here is clearly an arbitrary one and is based on far less satisfactory evidence than that almost infinite variety of phenomena which form the basis for our assumption of the existence of atoms. The writer of this review does not claim that the existence of atoms has been proved, but he does claim that the truth of natural laws is also not proved, and that while natural laws and the atomic theory differ greatly in the complexity of the phenomena on which they are based, they do not, philosophically speaking, differ in their fundamental nature.

On page 48 he suggests the term 'molar weight' in place of molecular weight. This would be very unfortunate in English since the word molar is used by us in a quite different sense.

On page 112 we find the erroneous statement that 'sulphuric acid is bibasic because it contains two combining weights of hydrogen.'

On pages 82 and 139 it is stated that every transformation or reaction produces the less stable form of an element or compound. Professor Ostwald seems to accept this law as a sort of axiom without attempting to give any reason for it. It appears to the writer of this review as closely related to Berthelot's erroneous law that every chemical reaction takes place with the evolution of the maximum amount of heat. Both laws are based on a desire to explain chemical reactions by a

simple consideration of the energy relations involved. If the law were true, all reactions which give oxygen at ordinary temperatures should give it in the form of ozone. The fact that some such reactions give ordinary oxygen while others give ozone is doubtless connected, in some cases, at least, with the structure of the reacting compounds as well as with their inherent energy. And no one has thus far told us how a satisfactory account of matters connected with chemical structure can be given without the aid of the atomic theory.

One hesitates to criticize a book of such surpassing excellence and one destined to be so very useful. But those very qualities which have made Professor Ostwald so much beloved by all of his acquaintances and which have given him such an extraordinary hold on his students, seem to lead some of them to accept almost without question everything which he writes and it seems right that a divergent view should sometimes find expression.

WILLIAM A. NOYES.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for February contains articles on 'The Unity of the Gnathostome Type,' by Howard Ayers; 'Old Age in Brachiopoda—a Preliminary Study,' by H. W. Shimer; and 'The Habits of *Necturus maculosus*,' by A. C. Eycleshymer. Dr. Ayers concludes that the Marsipobranchs are true Gnathostomata and that the only living Acraniate is Amphioxus. Dr. Shimer's article gives a summary of the principal characters that accompany old age in the brachiopods and includes many illustrations of typical examples besides presenting suggestions as to their origin and meaning. Professor Eycleshymer discusses the habits of *Necturus* at some length, giving much new and interesting information in regard to its nests and breeding habits. We quite agree with him that any specimen over a foot in length is unusually large.

The University Bulletin, University of Michigan, for December, 1905, contains the report of the curator of the museum. Mr. Adams is to be complimented upon having accomplished much with a small expenditure of money and on having done much by collecting, and rearranging and labeling the museum collections, to promote its efficiency. The chief accessions were 131 skins of mammals, representing 23 species, and 298 birds of 111 species.

Colorado College Publications, Science Series, No. 46, is devoted to an annotated list of 'The Mammals of Colorado,' by E. R. Warren. This contains a very considerable amount of information compressed into a few pages and is accompanied by a bibliography.

The Quarterly Record of Additions to the Museum of Hull, England, is an excellent device for economical and extensive publication. Objects of interest are described in the *Eastern Morning News,* electrotypes made of the articles, and each quarter these are combined and issued in pamphlet form as one of the museum publications.

SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 412th regular meeting was held on February 17, 1906, with Vice-president Palmer in the chair and thirty-two persons present.

Professor Paul Bartsch presented a paper on 'Variation in the Shell of *Goniobasis virginica,* with an Outline for Breeding Experiments.' He described and illustrated with lantern slides the wide differences among individuals of this species. Collections from the vicinity of Mount Vernon in tidewater subject to an occasional slight salinity are constant in form. Those from the Shenandoah at Harpers Ferry likewise show little variation, though plainly recognizable from the Mount Vernon representatives of the species. About Washington the shells show extreme variation. Intergrades everywhere exist and the subspecific groups all run together. Without attempting to account for these variations, experiments were proposed calculated to throw light on the subject. These consisted substantially in transplanting the local forms and studying their progeny under the new conditions. In the Shenan-

doah at Harpers Ferry are to be held, in a series of screened troughs, a few thousand specimens of the Mount Vernon form, in another series a mixture of equal numbers of Mount Vernon and Harpers Ferry specimens, a third series to be empty as a check upon the results. At Mount Vernon or at the southern limit of the range of the species, and at Washington, these series are to be repeated. Such trials would be expected to yield interesting and valuable, even if negative, results.

Under the title 'The Nature of Evolutionary Motion' Mr. O. F. Cook gave an exposition of his kinetic theory, and showed how the interpretation of evolutionary factors differs from that of other doctrines. It was held, in particular, that isolation and natural selection are not at all factors of evolution in any strict and scientific sense; they conduce to the differentiation of new species (speciation), and to increased fitness (adaptation), but have no power to actuate the process of organic change in species (evolution). The principal agent of evolutionary progress is the normal interbreeding of the normally diverse individuals of which species are composed. Evolution is thus an intraspecific phenomenon, instead of being interspecific. The intraspecific differences which contribute most to evolutionary motion are not those which arise as adjustments to different conditions of the environment (artism), but those which are independent of environmental adjustments (heterism).

Outlines and diagrams were shown in explaining the bearing of these distinctions upon the four principal types of evolutionary theories, static, saltatory, determinant and kinetic. Static theories were defined as those which view the species as normally stationary, though moved occasionally by environmental causes. Saltatory theories prescribe motion of an intermittent character and at remote intervals. Naegeli's determinant theory held that species move in a single definite direction as a result of causes inherent in the organisms. The kinetic theory provides for an indeterminate, composite motion resulting from the continuous interbreeding of the diverse individuals of the species. Selection does not cause this motion, but can restrict and deflect it, and can thus lead evolution in adaptive directions. Saltatory and determinant theories do not provide for any practical adaptive influence on evolution. Although completely denying the current assumption that selection is the cause or active principle of evolution, the kinetic theory provides better than any other for a practical explanation of the manner in which selection induces adaptation.

The 413th meeting was held March 3, 1906, President Knowlton in the chair and thirty-two persons present. Dr. L. O. Howard presented the first paper on 'The Gypsy Moth and the Brown-tailed Moth and the Introduction of their European Parasites,' illustrated with lantern slides. He described the accidental introduction of the gypsy moth into Massachusetts by the escape of an egg mass from some breeding experiments in 1868. In 1900 after spending a million dollars in fighting the insect the state stopped the work and the moth gained ground until last year when the state appropriated $300,000 to be spent during three years. $10,000 was also appropriated for the introduction of its parasites and one half this sum was turned over to Dr. Howard for the furtherance of this object. He has imported from Sardinia 2,500 of the parasite-infested larvæ. The moth has American parasites, but the percentage of infected larvæ is lower, and the tree infection much greater in America than in Europe. The illustrations showed graphically the entire defoliation of trees caused by the caterpillars and the large scale in which the campaign against them is conducted,—by banding trees, creosoting the egg masses and burning over underbrush with the blast torch.

The brown-tailed moth was brought over in the winter cocoon stage, a nest of leaves bound together and containing larvæ. Unlike the gypsy moth the adult is a good flier and, therefore, disseminates more directly and rapidly and its spread is a foregone conclusion.

Professor A. S. Hitchcock read a paper entitled 'A Synopsis of the Genus Tripsacum.'

Tripsacum is a genus of grasses extending from the southern United States to South

America. The common species, *T. dactyloides* (L.) Willd., is found from southern New England along the coast to Mexico, and in the interior as far north as Iowa and Nebraska. A subspecies occurs in Mexico (*T. dactyloides hispidum* Hitchcock). Two other species occur in the United States, *T. floridanum*, confined to the vicinity of Miami, Florida, and *T. lemmeni* confined to southern Arizona and northern Mexico. Four additional species inhabit Mexico and Central America, *T. fasciculatum, T. lanceolatum, T. pilosum* and a new species, *T. latifolium*. In order to show the relationship of this new species to the others of this genus the whole group was worked over. The paper consisted of a key to species followed by descriptions, citation of specimens and critical notes. The genus was divided into two sections. The staminate spikelets are in pairs at each joint of the spike. In section I. these spikelets are both sessile (*T. dactyloides* and its allies). In section II. one of the spikelets of each pair is pedicelled (*T. fasciculatum* and its allies).

M. C. MARSH,
Recording Secretary.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

Meeting of January 8, 1906.—Vice-President Hovey in the chair. The following papers were read:

Geological Notes on the Western Sierra Madre of Chihuahua, Mexico: Dr. EDMUND OTIS HOVEY.

The paper gave a concise résumé with the aid of lantern slides, of observations made by the author upon an expedition made for the American Museum of Natural History in February, March and April, 1905. The route lay southwestward and southward from Ciudad Juarez to Ocampo, thence to the railroad again at Miñaca. The development of bolson deserts in arid regions and the similar bolson basins in the less arid regions was described. These bolsons have normally no external drainage, but in many cases they have been invaded by streams from without. The Aros River has cut through several such enclosed basins, as is shown by the remains of local conglomerates and sandstones. The section exposed in the deep canyon of the Aros shows that a foundation of Cretaceous (?) limestone has been covered by old andesitic eruptives; that continental movements have raised, tilted, faulted and metamorphosed the limestone, producing schists from clayey beds; that granite has been intruded under and into the limestone; that later and more acid lavas and tuffs (dacites and rhyolites) have been poured out or deposited over the region; that the latest outflows were of basaltic lavas; that the local conglomerates and sandstones have been formed in constructional basins by the disintegration of the mountain slopes. Many other points of geologic interest were brought out in the photographs.

Discovery of the Schoharie Fauna in Michigan: A. W. GRABAU.

Recent examination of the limestones of the Mackinaw region for the Michigan Geologic Survey showed the existence of the Schoharie fauna in the basal portion of the Dundee formation, in a number of localities in the northern part of lower Michigan; notably at Mill Creek, near Mackinaw City, and on Mackinaw Island. Such typical species as *Trochoceras clio, Atrypa impressa, Rhipidomella alsa, Conocardeum cuneus, Phacops cristatus,* etc., characterize this fauna. The strata containing it rest directly upon beds with *Leperditia cf. scalaris,* and, therefore, of lower Manlius (Greenfield limestone or Cobleskill) age, from which they are separated by a pronounced disconformity. The finding of this fauna fixes the date of the great mid-Devonic transgression.

Preliminary Note on Sporadic Occurrence of Diamonds in North America: GEORGE F. KUNZ.

Dr. Kunz pointed out the general features of the occurrence of diamonds in North America, reserving the more complete discussion for the next meeting.

A. W. GRABAU,
Secretary.

COLUMBIA UNIVERSITY.

THE TORREY BOTANICAL CLUB.

THE meeting of February 13 was called to order at the American Museum of Natural History by the secretary, at 8:30 o'clock. Owing to the absence of the president, Dr. N. L. Britton was called to the chair. Twenty-three persons were present.

A paper by Dr. Arthur Edwards, on the 'Origin of the Bacillaria,' was read by its title and referred to the board of editors with power.

The paper of the evening was an illustrated lecture by Mr. George V. Nash, on the 'General Botanical Features of Orchids.'

There seems to be a general misconception among many as to just what an orchid is. Any plant which grows on a tree, or has some peculiar feature is, without hesitation, called an orchid. This mistake is frequently made in regard to the pitcher plants, *Nepenthes*, or to the tail-flowers, *Anthurium*. In order more clearly to define the structure of the orchid flower, a large flower of the genus *Cattleya* was illustrated on the screen. The uniting in one organ, called the *column*, of the stamens and pistils, serves at once to distinguish this family from all related ones. The diandrous and monandrous forms of this column were described and illustrated with lantern slides, as were the other features of the family. The two kinds of pollinia were explained, that which develops appendages at the base, and that which is without appendages, or develops them at the apex, the former associated with the persistent anthers, the latter with the deciduous anthers. Attention was called to the thickened stems of most orchids. In some the stem is very short and much enlarged. Such stems are known as *pseudobulbs*. *Oncidium* and *Odontoglossum* are examples of this sort. In others the entire stem is thickened, as is the case in *Cattleya* and *Dendrobium*. The lateral and terminal forms of inflorescence were described, the former arising from the base of the pseudobulb, the latter from its apex. The venation of the leaves, whether convolute or conduplicate, was illustrated. The manner of growth, whether limited or unlimited, was indicated; the limited in such genera as *Epidendron, Oncidium, Odontoglossum, Masdevallia* and in fact the greater part of the orchids; the other, the unlimited, in such genera as *Vanilla*, and *Angræcum*, in which the axis ascends continuously.

The latest comprehensive treatment of this interesting family is by Pfitzer, in Engler and Prantl's 'Natürlichen Pflanzenfamilien.' In his classification he utilized the characters and habits of growth referred to above.

The orchid family is a large one, embracing some 6,000 or 7,000 species, mostly distributed in tropical regions. Comparatively few are found in the warm temperate, and almost none in the cold portions of the temperate zone. The center of their distribution in the old world is in India and the Malay region. Such genera as *Dendrobium, Vanda* and *Bulbophyllum* represent these. In the new world they are found in the greatest numbers in Brazil and northern South America. Such genera as *Cattleya, Lælia* and *Masdevallia* illustrate these. In the United States there are about 150 species, representing 44 genera. These are mainly terrestrial, the comparatively few epiphytes being confined to Florida and the gulf states.

By far the greater part of the orchids grow in hot humid regions, where they are found almost exclusively growing on trees, or epiphytic. The terrestrial species in the tropics are relatively few. The epiphytes usually have thick fleshy leaves, and these and their thick stems serve as storage organs, for their water supply is precarious. While it is true that most orchids like humid conditions, this is not always the case. During an exploration of the Inaguas, which are extremely xerophytic, great masses of epidendrons were found growing on the bases of the small shrubs or trees, or on the hot limestone rock; and to emphasize this desert condition, was a species of *Agave* growing among them. They seemed to flourish, for the pseudobulbs were strong and vigorous.

Nearly all tropical orchids are epiphytic, while in temperate regions they are terrestrial, the soil around their roots protecting them from the extreme cold of winter. As a rule terrestrial orchids have thin leaves, for their

water supply is not so limited as is the case with epiphytic orchids.

In distribution orchids are very local. Few genera are common to both the old world and the new, and when they are common to both, the distribution is a zonal one. The genus *Cypripedium*, as at one time understood, was a supposed exception to this. Recent authors, however, basing their conclusions upon well-defined structural differences in the flowers, have divided this, at one time cosmopolitan, genus, into four genera, each of the four genera with a well-defined geographical distribution. We have now, instead of the one big genus, the following:

Selinepedium, new world, with 3 species, known only from Central America to Brazil.

Cypripedium, old world and new, but zonal in distribution, with 28 species, north temperate.

Phragmipedium, old world, with 11 species, tropical America only.

Paphiopedilum, old world, with 46 species, tropical Asia, Malaya, Philippines, etc.

As genera typical of a zonal distribution, there were mentioned: *Cypripedium*, *Pogonia* and *Limodorum*. Among the genera peculiar to the new world are: *Masdevallia*, *Pleurothallis*, *Epidendron*, *Cattleya*, *Lælia*, *Lycaste*, *Maxillaria*, *Odontoglossum*, *Miltonia*, *Oncidium* and *Dichæa*.

Among those confined to the old world are: *Thunia*, *Cœlogyne*, *Pleione*, *Ansellia*, *Phagus*, *Dendrobium*, *Eria*, *Bulbophyllum*, *Cymbidium*, *Phalænopsis*, *Vanda*, *Angræcum* and *Ærides*.

The different features were illustrated with lantern slides, many of them colored. The latter were the work of Mrs. Van Brunt, and were kindly loaned for the occasion by her.

Alluding to Mr. Nash's discussion of the satisfactory breaking up of the old genus *Cypripedium* into four genera, and the restriction of *Cypripedium* to its type species and immediate relatives, having a well defined zonal distribution, Dr. Britton remarked upon the wide application of this principle in the progressive study of plants and animals, causing the recognition of very many more genera than were believed to exist by most botanical and zoological students in the last century.

The vastly greater number of species now known, and their more critical comparative study in the field and in collections, as well as the more exact understanding of long-recognized species, show that the number of homogeneous groups which we call genera, existing in nature, is larger than previously supposed. The genus *Habenaria* has recently been subdivided into several genera, and this subdivision has been a distinct advance in the taxonomy of orchids.

C. STUART GAGER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A NEW TYPE OF ELECTRIC ORGAN IN AN AMERICAN TELEOST FISH ASTROSCOPUS.

JORDAN in his last book on fishes (1905) mentions that *Astroscopus* gives an electric shock, quoting Gilbert and others as his authorities. He also states that Professor Agassiz and others felt an electric shock from *Urophycis regius*. Dr. Gilbert, of Stanford University, kindly wrote me, in answer to inquiries, stating that he had felt electricity in *Astroscopus*, and that another collector had felt it in a Pacific specimen. These facts were mentioned in the bulletin of the National Museum.

I have examined *Urophycis* carefully and find no trace of electric organ, but have found that *Astroscopus* does possess a highly developed if small electric organ.

It consists of two masses of tissue, one lying behind each eye and extending as an approximately round column from the bare spot on the skin behind the eye down to the roof of the mouth. Like *Torpedo* it is composed of thin electric plates or 'electroplaxes' that lie in a horizontal position.

The electroplaxes do not occupy the full width of the column, but are much smaller and overlap and imbricate. Each one is a wide, thin syncytium, markedly different from any form yet described.

Its neuro-electric surface is smooth and has a thin structureless layer containing very few nuclei. Its other surface is raised into a close-set series of long, evaginated papillæ that

anastomose somewhat. They project into the jelly tissue that fills the remainder of the compartment.

A remarkable feature is the striation of the substance of the electroplax. Even in the poor alcoholic material at my command, it stands out almost as marked and clear as in striated muscle, and it has much the same structure. As in *Raja,* these lines of striation are parallel but not straight; but, differing from *Raja,* they have an intermediate line and they are found in all parts of the papillæ and up to the electric layer. The presence of so much striated substance does not accord with Ballowtiz's view of the specialization and efficiency of electric tissue. That so small an organ should give so marked a shock puts it on a level with *Gymnotus* and *Torpedo,* both of which are supposed to have specialized their striated substance out of existence by developing the network for greater power.

However, it is not proper to go further into the question until I have prepared fresh material and studied the details of nerve endings, 'rod-net,' and coarse and fine network. Mr. C. F. Silvester has undertaken to work out the gross anatomy as part of this paper.

Ulric Dahlgren.

Princeton University,
January 28, 1906.

A NEW METHOD OF COLLECTING EARTHWORMS FOR LABORATORY USE.

For the benefit of teachers of biology who use the earthworm as one of the laboratory types it has seemed worth while to briefly report a method which has been successfully employed in my laboratory during the past two years, and which in the saving of time and labor we have found a very great improvement over the old methods of capturing them at night by the aid of a lantern, or by digging over the earth by means of a spade or such implement.

The method was first called to my attention by the care-taker of the golf greens on the university campus, who used a proprietary article, sprinkling it over the greens, following which the worms would emerge in great numbers from their burrows, and were then swept up and destroyed, thus relieving the surface of the annoyance of the castings.

This preparation is known by the name of 'Rushmore's Concentrated Worm Destroyer,' and may be had by the barrel of the manufacturer, Garden City, N. Y. It is, as indicated, a concentrated liquid, and for use must be diluted with about one hundred and fifty times its bulk of water. In using, it is simply sprayed over the lawn, where worms are known to abound, from an ordinary watering pot till the surface is well saturated. Within five minutes, usually, the worms begin to emerge from their holes and may be collected and placed at once in clean water, which should be changed several times in order to remove all trace of the irritant, in order that they may not distort themselves and thus be injured as specimens. They may then be narcotized after the usual method and preserved in either alcohol or formalin. In using such specimens for dissection they have been found to be quite as good as those taken by older modes of collection.

We have found it quite important to use a greatly diluted preparation, otherwise it tends to drive the specimens deeper into the burrows and thus fail of its object.

Commenting upon the method among some of the students it was discovered that similar methods have been used by others, though involving greatly differing media. For example, it was said that when using a very dilute solution of corrosive sublimate, one part in ten thousand, for killing potato 'bugs,' in many cases earthworms would emerge in the same manner as in the former. Again, it was also learned that to obtain angle worms for bait a decoction of mustard in water had been sprinkled over the ground, in response to which specimens would readily come to the surface.

It would seem, therefore, that probably any of several such means might be employed successfully. The proprietary article has a considerable use among keepers of golf links, and where so used one may easily take advan-

tage of it to secure an abundance of specimens at little or no cost.

CHARLES W. HARGITT.

SYRACUSE UNIVERSITY,
THE ZOOLOGICAL LABORATORY.

SPECIAL ARTICLES.

EFFECT OF DRYING UPON LEGUME BACTERIA.

THE almost simultaneous appearance of Bulletin No. 270 of the Geneva (New York) Experiment Station and Farmers' Bulletin, No. 240 of the United States Department of Agriculture, the one stating that cultures of nodule-forming bacteria dried on cotton were worthless for practical purposes and that the failure of these cultures was inherent in the method of their preparation, the other stating that the Department of Agriculture did not consider cultures dried on cotton entirely satisfactory and would instead distribute liquid cultures hermetically sealed, has perhaps naturally resulted in unwarranted and unfairly severe criticism toward the cultures dried on cotton.

The most misunderstood feature in the deterioration of dried or partially dried cultures is the distinction between the effect of desiccation *per se* and the effect of small quantities of moisture present for some length of time, either because of slow drying or because of absorption of water vapor from a humid atmosphere after the cotton had been thoroughly and rapidly dried. It has, therefore, been considered desirable to publish at once an explanation of the simple paradox that the rapid drying of cultures of nodule-forming bacteria causes a relatively insignificant injury to them, while the partial drying of similar cultures will cause them to deteriorate and die rapidly. The time of danger to a drying culture is the time of high concentration of the soluble substances. This condition necessarily obtains when the culture is almost dry. Whether one wishes to base his explanation chiefly upon the antiseptic action of concentrated sugar and salt solutions[1] or upon the deleterious action of by-products[2] which must also be highly concentrated in the almost dry culture, it is necessary to admit that the longer a given culture is exposed to these adverse conditions the fewer bacteria will be able to survive; and as the necessary corollary, the more often a properly dried culture is allowed to become moist the greater will be the deterioration of that culture.

This explanation is deduced from the following facts:

1. Cultures of nodule-forming bacteria have been rapidly dried, kept in a desiccator for thirty days, sixty days and ninety days, and revived with no apparent difference in the three series.

2. Cultures dried as above have been exposed to moist air for ten days and for twenty-four days. In some cases contaminations destroyed the proper organism; in others complete sterility obtained; in a few cases a few organisms remained in cultures otherwise sterile.

3. Cultures ten days old were evaporated in vacuo, and into the concentrated broth heavy inoculations were made. These tubes were sterile at the end of seventy-two hours.

4. Our regular sugar-broth was made up approximately twenty times as concentrated as our regular formula, and this medium was heavily inoculated with actively growing cultures. By the end of seventy-two hours these tubes were sterile.

5. A culture has been placed on cotton, half of which was placed in a sterile petri dish, to make drying very slow, half was dried rapidly and kept over calcium chlorid. After twenty-five days the cotton in the petri dish was sterile; the cotton from the desiccator was a pure culture in good condition, containing numberless organisms.

We may summarize briefly as follows:

The nodule-forming bacteria of the Leguminoseæ may be dried rapidly and kept in a dry condition for long periods,[3] and may then be revived successfully.

Cultures properly dried may be killed by exposure to moist conditions.

[1] Sternberg, 'Manual of Bacteriology,' 1893, p. 156.

[2] John Golding, *Journal of Agricultural Science*, Vol. I., Pt. 1, p. 59–64.

[3] See also Bulletin No. 71, Bureau of Plant Industry.

Slow drying will kill a culture that will remain in good condition after rapid drying.

A highly concentrated medium comparable to that which the almost dry cultures must endure will kill the bacteria in question in an exposure of a few days.

Karl F. Kellerman,
T. D. Beckwith.

Bureau of Plant Industry,
Washington, D. C.

CURRENT NOTES ON METEOROLOGY.

HELM CLOUDS IN NORTH CAROLINA.

In the *Monthly Weather Review* for October, 1905, Frank W. Proctor mentions the occurrence of standing clouds in atmospheric waves at Waynesville, N. C. (see also Science, May 1, 1903, page 712). This place is surrounded on three sides by high and steep mountains, and the topography is favorable for the formation of such clouds. On the day when the observation was made the wind was southwest, and blew across the mountain range which forms the head of the valley. A large dense standing cloud was formed over the mountains, carried down on the lee side for a short distance, and was seen to evaporate at its leeward edge as fast as it developed to windward. About a quarter or a half a mile to leeward, at the same level approximately, and separated from this main cloud by a clear space, there was a second, detached, standing cloud of good size, also forming to windward and evaporating to leeward like the primary cloud. The wind at the level of the clouds was blowing at the rate of twenty miles an hour, yet the clouds were stationary, dissolving as rapidly at one side (lee) as they formed at the other (windward). Mr. Proctor's account of these helm clouds in the mountains of North Carolina is the second mention of this phenomenon. The first was made by Professor W. M. Davis (*Bull. Geogr. Soc. Phila.*, III., No. 3, 1903).

DAILY MARCH OF TEMPERATURE IN THE TROPICS.

Hann has undertaken an extended investigation of the daily march of temperature in the tropics, the first part of which has been published ('Der tägliche Gang der Temperatur in der inneren Tropenzone,' *Denkschr. k. Akad. Wiss., math.-naturw. Kl.*, Vienna, 1905, Vol. LXXVIII.). The reason for taking up this study is found in the fact that the mean temperatures of many stations in the tropics are placed too high because of the application of inaccurate corrections in computing the true means. The present work is to be regarded as an extension of that of Dove, published in 1846 and in 1856 ('Ueber die täglichen Veränderungen der Temperatur der Atmosphäre,' *Abhandl. Berl. Akad.*), and includes the latest available observations from stations between the equator and latitudes $\pm 15°$ N. and S., in Africa, the West Indies, Central and South America, southern Asia, northern Australia and the tropical oceans.

RAINFALL OF MEXICO.

A report on the 'Regimen of the Rainfall of Mexico,' in the twelfth volume of the *Annals of the Association of Engineers and Architects of Mexico,* by Romulo Escobar, brings to light an interesting fact. Most of the stations show a steady diminution in rainfall for a long period of years, but this decrease has already begun to be followed by an increase. Our gulf states from Texas to Alabama and Tennessee have shown a similar decrease, but the expectable increase has not been observed everywhere, owing, as Professor Abbe believes, to the frequent changes in the rain gauges and their exposures. It is to be noted with satisfaction that in this report on Mexican rainfall there is no indiscriminate comparison of a long record at one station with a short record at another, the rainfalls being averaged for each station by lustra, so that mean annual rainfalls for the same period may be compared (*Mo. Wea. Rev.*, Oct., 1905).

NOTES.

According to a list recently published in *Petermann's Mittheilungen* (1905, p. 91) it appears that out of forty-four universities and technical schools using the German language, thirteen recognized meteorology as worthy of special mention in their courses of instruction offered during the past summer semester.

THE third annual issue of the volume on 'Meteorology' of the International Catalogue of Scientific Literature, dated October, 1905, contains chiefly titles belonging to the year 1903 and the earlier part of 1904. The number of pages is 235, as against 296 in the second annual issue (1902) and 184 in the first. Such a bibliography as this, unsatisfactory as it is in some respects, is certainly a very great help to the working meteorologist and climatologist.

OBSERVATIONS at the meteorological observatory at Perpignan during the solar eclipse of August 30, last, showed a fall of 6.7° in temperature; a rise of 12 per cent. in relative humidity; no 'eclipse wind,' but rather a calm (*Ciel et Terre,* December 16, 1905).

REFERENCE has been made in SCIENCE to the work carried out by the Blue Hill Observatory staff at St. Louis in 1904 with the aid of *ballons-sondes.* Mr. A. Lawrence Rotch, in the *Proceedings of the American Academy of Arts and Science,* Vol. XLI., No. 14, December, 1905, describes this investigation under the title 'On the First Observations with Registration Balloons in America.'

R. DEC. WARD.

BOTANICAL NOTES.

BOTANICAL ARTICLES IN RECENT PERIODICALS.

IN the *Iowa Naturalist,* for October, R. I. Cratty monographs the *Juncaceae* of Iowa, distinguishing nine species of the genus *Juncus,* and two of *Juncoides.* In the same number, T. J. Fitzpatrick publishes his treatment of the *Melanthaceae* of Iowa, in which he includes one species of *Zygadenus,* one of *Melanthium,* one of *Veratrum,* and three of *Uvularia.*—'The Willows of Ohio' is the title of a monograph by R. F. Griggs in the Proceedings of the Ohio State Academy of Science (pt. 6, Vol. IV.). It covers fifty-eight pages and includes keys, descriptions and halftone reproductions of photographs by means of which the twenty-two species and varieties are well distinguished.—F. L. Sargent's articles, 'Lichenology for Beginners,' published in the *Bryologist* in 1905, have now been issued as a twenty-page pamphlet. It presents in simple language the essential structural facts in regard to lichens. The text is made still plainer by a number of cuts of fruits and spores. The pamphlet closes with a useful artificial key to the common eastern species.—It is a pleasure to record the completion (December, 1905) of Forbes and Hemsley's 'Enumeration of all the Plants known from China proper, Formosa, Hainan, Corea, the Luchu Archipelago, and the Island of Hongkong, together with their Distribution and Synonomy,' which has been in course of publication in the *Journal of the Linnean Society* for many years. The enumeration contains 8,271 species, of which 4,230 are not known to occur outside of the Chinese empire. It is estimated that the total number of species when known, will reach at least twelve thousand.—In the *Records of the Botanical Survey of India* (Vol. IV., No. 2), Sir J. D. Hooker publishes an epitome of the British Indian species of *Impatiens.* He records sixty-three species from the eastern Himalayas from central Nepal to Upper Assam, and fifty-two species from the Burmese region. The well-known cultivated species, *Impatiens balsamina,* occurs wild in both regions.—Engler's 'Pflanzenreich' has reached the twenty-second 'heft' which is devoted to the family *Primulaceae,* elaborated by F. Pax and R. Knuth. The 530 species are assigned to twenty-two genera, in five tribes. Of the latter, the tribe *Androsaceae* is by far the largest, containing 361 species. The larger genera are *Primula* with 208 species; *Androsace,* 84; *Dodecatheon,* 30; *Cyclamen,* 16; *Lysimachia,* 110; and *Anagallis,* 24. The treatment is conservative, both as to generic and specific limitations. No new genera are set up, and few new species are described. However, when some modern species-maker gets into the family, he'll find an abundance of varieties ready to his hand for elevation to specific rank.

CRYPTOGAMAE FORMATIONUM COLORADENSIUM.

FOUR years ago F. E. and E. S. Clements issued their 'Herbaria Formationum Coloradensium,' consisting of about six hundred sheets of specimens of higher plants, ar-

ranged so as to illustrate the vegetative formations of the Pike's Peak region of Colorado. Every set was promptly taken, showing that there is a demand among botanists for something more than the old-time collections of mere specimens. This fact has encouraged the authors to begin the publication of a similar set of lower plants, under the title of 'Cryptogamae Formationum Coloradensium,' centuries I. and II. of which were issued to subscribers some months ago. This is apparently the first serious attempt to treat adequately with respect to their ecological relations the lower plants (cryptogams) of a particular region. The centuries thus far issued include of Pyrenomyceteae 50 sheets; Fungi Imperfecti, 19; Discomyceteae, 62 (23 'lichens'); Uredineae and Ustilagineae, 24; Basidiomyceteae, 39; and Musci, 6. Three new genera and twelve new species are represented. With the specimens are forty photographs, consisting of plant portraits, and views of fungus and moss communities.

RECENT BOTANICAL BULLETINS.

Among the recent botanical bulletins may be noticed Kellerman and Robinson's 'Inoculation of Legumes' (Farmers' Bulletin No. 240, U. S. Department of Agriculture), in which directions are given for the practical use of cultures of nitrogen-fixing bacteria. The conditions under which soil inoculation is desirable or undesirable are clearly set forth for the guidance of the farmer.—The 'Wild Medicinal Plants of the United States' are brought together in a useful annotated alphabetical list by Alice Henkel (in Bulletin No. 89, of the Bureau of Plant Industry). Brief descriptions are given, with the range of each species, the scientific and common names, and the family to which each belongs.—The same author discusses 'Peppermint' in Pt. III. of Bulletin No. 90 of the Bureau of Plant Industry, and Albert C. Crawford, 'The Poisonous Action of Johnson Grass' (*Sorghum halapense*) in Pt. IV. of the same bulletin. Apparently this grass must now be added to the already considerable number of plants which produce hydrocyanic acid in poisonous quantities under certain conditions.—In Circular No. 36 of the Forest Service, Gifford Pinchot tells what the service is, and how it deals with forest problems. Its perusal will no doubt be quite enlightening to many people. —Suggestive and helpful are Chapman's 'Working Plan for Forest Lands in Berkeley County, South Carolina' (Bull. No. 56), and Clothier's 'Advice for Forest Planters in Oklahoma and Adjacent Regions' (Bull. No. 65) in which photographs and maps help the carefully written text.—Of more direct interest to the botanist, is Kellogg's 'Forest Belts of Western Kansas and Nebraska' (Bull. No. 66) in which he discusses the distribution and natural extension of the forest belts in these two states on the great plains.—In the Report of the Experiment Station Committee of the Hawaiian Sugar Planters' Association, for the year 1905, a considerable amount of space is given to the newly established division of pathology and physiology, to the directorship of which Dr. N. A. Cobb (of New South Wales) was called less than a year ago. The laboratory with some of its peculiar apparatus and mountings is described, and a program of the work to be undertaken is given with some detail. With such an outfit, and apparently with ample funds, we may look for good work from Dr. Cobb and his corps of assistants.

THE KEW PUBLICATIONS.

In the last Bulletin of Miscellaneous Information (No. 1, 1905) of the Royal Botanic Gardens of Kew, is given a 'select list' of the works prepared by members of the staff or in collaboration with such members. About eighty titles are cited, ranging from such serials as *Curtis's Botanical Magazine*, and the *Annals of Botany*, to the standard works like *Flora Australiensis* (7 vols.), *Biologia Centrali-Americana* (5 vols.), *Genera Plantarum* (3 vols.), Sachs's *Text-Book of Botany*, and finally to thin pamphlet hand-lists and guide books. It is a most useful and instructive list, especially to botanists who are trying to fill their libraries with desirable books. Incidentally it will serve to show what a center of botanical activity these gardens have been during the past forty or fifty years. A very

useful feature of the list is the citation in every case of the time and place of publication, and the name of the publisher.

MONTANA BOTANY.

WITHIN the past few months Professor Blankinship has published numbers 1, 2 and 3 of the 'Montana Agricultural College Science Studies,' including three botanical papers of much more than usual interest. The first of these, 'A Century of Botanical Exploration in Montana,' includes a chronological list of seventy-four collectors who have worked in the state, beginning with Meriwether Lewis, of the Lewis and Clarke expedition in 1805 and 1806, and ending with Millie M. Smith and Arthur Lehman in 1904. The bibliography includes eighty-three titles.

The second paper is a 'Supplement to the Flora of Montana,' and includes additional species, and corrections of the list given in Dr. P. A. Rydberg's 'Catalogue of the Flora of Montana and the Yellowstone National Park' (Memoirs N. Y. Bot. Gard., 1900). There are about three hundred and eighty-six additions, seventy-eight corrections and twenty-eight new species and varieties. Apparently the author has been conservative in his treatment of both old and new species, and apparently the corrections have been made with care. This list is a valuable and notable addition to our knowledge of Montana flowering plants, and must prove very helpful when the descriptive botany of the region comes to be written.

The third paper consists of lists of the common names of Montana plants. Every plant is entered twice, once alphabetically under its common name, and again in a similar list in which the scientific names are arranged alphabetically. It is a valuable contribution to the botany of common names, and serves very well to show how variable and unreliable such names are.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE MAGNETIC SURVEY OF THE PACIFIC OCEAN: SECOND CRUISE.

THE Yacht *Galilee,* engaged in the magnetic survey of the Pacific Ocean under the auspices of the Carnegie Institution of Washington, left San Diego, California, on March 2, to enter upon her second cruise. She is expected to make the following circuit of about 20,000 miles by the end of this year: San Diego, Fanning Islands, Samoan Islands, Fiji Islands, Marshall Islands, Guam, Yokohama, Aleutian Islands and back again to San Diego.

It was necessary to reorganize the scientific personnel as those of the former staff belonging to the U. S. Coast and Geodetic Survey were obliged to return to their official duties at the expiration of their furloughs. The command of the vessel has accordingly now been entrusted to Mr. W. J. Peters, formerly of the astronomical and topographical corps of the U. S. Geological Survey. He has had considerable experience in difficult geographical work, was second in command and in charge of the scientific work of the recent Ziegler Polar Expedition as the representative of the National Geographic Society.

In connection with the latter expedition, Mr. Peters made a valuable series of magnetic, meteorological and tidal observations at Teplitz Bay, Franz Joseph Land.

The other members of the present staff are: Mr. J. P. Ault, magnetic observer (likewise a member of the former staff), Mr. J. C. Pearson, magnetic observer (formerly instructor of physics at Bowdoin College) and Dr. H. E. Martyn, surgeon and recorder. The sailing master is Captain J. T. Hayes. While the vessel was at San Diego some additional changes and improvements were made both in the ship and in the instruments employed. Sufficient funds have been allotted so as to permit carrying on this work continuously throughout the year.

L. A. BAUER.
DEPARTMENT TERRESTRIAL MAGNETISM,
March 10, 1906.

UNIVERSITY CONTROL.

IN the colleges from which our universities have developed the problem of administration was comparatively simple. The faculty and the president met weekly and consulted daily; each was familiar with the work of the entire

institution; a spirit of cooperation and loyalty naturally prevailed. The trustees also understood the economy of the college and were able to work intelligently for the general good. But when a university covers the whole field of human knowledge, when it is concerned with professional work in divergent directions, when it adds research and creative scholarship to instruction, when both men and women are admitted, when there are 500 instructors and 5,000 students, it is no longer possible for each trustee and for each professor to share intelligently in the conduct of the whole institution. We appear at present to be between the Scylla of presidential autocracy and the Charybdis of faculty and trustee incompetence. The more incompetent the faculties become, the greater is the need for executive autocracy, and the greater the autocracy of the president, the more incompetent do the faculties become. Under these conditions it appears that the university must be completely reorganized on a representative basis. It should not be a despotism and it can not be a simple democracy. Autonomy should be given to the schools, departments or divisions. The administrative, legislative and judicial work must be done by experts, but they should represent those whom they serve.

In the course of the past few months there have appeared in various quarters articles discussing the problems of university and educational administration. Two of these contributions—one by Ex-president Draper in *The Atlantic Monthly* and one by President Andrews in the *Educational Review*—laud the university president and his office, but the other articles which have come to my attention are criticisms of the absolutism and commercialism that are alleged to obtain in university control. Editorial discussion from this point of view has appeared in *The Nation, The Outlook, The Dial, The Congregationalist* and other journals. Articles by President Pritchett in *The Atlantic Monthly,* by Professor Stevenson in *The Popular Science Monthly,* by Mr. Munroe in Science and by the present writer in *The Independent* adopt a similar attitude.

The articles referred to are in the main attacks on the transference to university administration of methods current in business and in politics. Several suggestions of a constructive character have, however, been made. Thus Professor Stevenson proposes that the presidency as it now exists should be abolished and that the faculty should make all appointments to the teaching staff, and Dr. Pritchett and Mr. Munroe suggest a joint council or committee of trustees and faculty.

The present writer ventures to propose tentatively the following form of organization for our larger universities, to be reached as the result of a gradual evolution:

1. There should be a corporation consisting of the professors and other officers of the university, the alumni who maintain their interest in the institution and members of the community who ally themselves with it. In the case of the state universities part of the corporation would be elected by the people. This corporation should elect trustees having the ordinary functions of trustees—the care of the property and the representation of the common sense of the corporation and of the community in university policy. The trustees should elect a chancellor and a treasurer who would represent the university in its relations with the community.

2. The professors or officers, or their representatives, should elect a president who has expert knowledge of education and of university administration. His salary should not be larger, his position more dignified or his powers greater than those of the professor.

3. The unit of organization within the university should be the school, division or department, a group of men having common objects and interests, who can meet frequently and see each other daily. It should be large enough to meet for deliberation and to represent diverse points of view, but small enough for each to understand the whole and to feel responsible for it. The size of this group is prescribed by a psychological constant, its efficient maximum being about twenty men and its minimum about ten.

4. Each school, division or department should elect its dean or chairman and its executive committee, and have as complete

autonomy as is consistent with the welfare of the university as a whole. It should elect its minor officers and nominate its professors. The nominations for professorships should be subject to the approval of a board of advisers constituted for each department, consisting, say, of two members of the department, two experts in the subject outside the university and two professors from related departments. The final election should be by a university senate, subject to the veto of the trustees. The same salaries should be paid for the same office and the same amount of work. The election should be for life, except in the case of impeachment after trial. The division should have financial as well as educational autonomy. Its income should be held as a trust fund and it should be encouraged to increase this fund.

5. The departments or divisions should elect representatives for such committees as are needed when they have common interests, and to a senate which should legislate for the university as a whole and be a body coordinate with the trustees. It should have an executive committee which would meet with a similar committee of the trustees. There should also on special occasions be plenums of divisions having interests in common and plenums of all the professors or officers of the university. There should be as much flexibility and as complete anarchy throughout the university as is consistent with unity and order.

J. MCKEEN CATTELL.

SCIENTIFIC NOTES AND NEWS.

FATHER J. G. HAGEN, S.J., professor of astronomy in Georgetown University, and director of the observatory, has been offered the directorship of the Vatican Observatory.

MR. ARTHUR STANLEY EDDINGTON, B.A., B.Sc. (Manchester), of Trinity College, Cambridge, senior wrangler in 1904, has been appointed chief assistant in the Royal Observatory, Greenwich.

DR. PAUL G. WOOLLEY, director of the serum laboratory of the Bureau of Science in the Philippines, has accepted under the government of Siam the directorship of the pathological laboratory, which it is proposed to start as soon as Dr. Woolley can reach Bangkok.

PROFESSOR JAMES MILLS PEIRCE, Perkins professor of mathematics and astronomy at Harvard University, has presented his resignation to take effect a year hence. Professor Peirce was appointed tutor in mathematics at Harvard in 1854.

PROFESSOR C. W. PRITCHETT has retired at the age of eighty-three, after thirty years' service, from the directorship of the Morrison Observatory at Glasgow, Missouri. He is succeeded by Mr. H. R. Morgan, formerly of the U. S. Naval Observatory.

DR. WILLIAM OSLER, regius professor of medicine at Oxford University, has been elected a member of the Athenæum Club, under the provisions which empower the annual election of nine persons 'of distinguished eminence in science, literature, the arts, or for public services.'

PROFESSOR PERCY F. FRANKLAND was elected president of the Institute of Chemistry of Great Britain and Ireland at the twenty-eighth annual meeting held on March 1. Professor Frankland's father, Sir Edward Frankland, was the first president of the institute.

DR. HUGO DE VRIES, professor of botany at Amsterdam, will present a paper on 'Elementary Species in Agriculture,' at the meeting of the American Philosophical Society, on April 18.

DR. E. D. FISHER has been appointed chairman of the committee on the centennial celebration of the Medical Society of the County of New York, which will be held at the Hotel Astor on April 4.

MR. DUDLEY MOULTON, A.B. (Stanford, '04), has been appointed a field agent of the Division of Entomology, U. S. Department of Agriculture.

DR. W. C. FARABEE, instructor in anthropology at Harvard University, took a party of Harvard students to Iceland during the summer. Mr. V. Stefánsson, Hemenway fellow in anthropology, and Mr. J. W. Hastings

(Harvard, '05) explored old Icelandic burial places and made a collection of skeletons of the earliest people of the island. Mr. Hastings also made anthropometric measurements of many of the Icelanders. The caves of Iceland are of volcanic origin and show no indication of having been occupied by man. No stone implements have ever been found on the island. These investigations led to the conclusion that the island was probably not inhabited prior to its settlement by the Norwegians in A.D. 874. Researches and collections were made by members of the party in geology and ornithology.

It is announced that the 'Reale Istituto Veneto di Scienze Lettere ed Arti' has decided to undertake a systematic study of the geophysical phenomena which, directly or indirectly, concern the lagoon of Venice. A special committee has been appointed for the purpose, and preliminary investigations on the subject of the tidal waves of the upper Adriatic, and the rivers flowing into it and the lagoon of Venice have been set on foot. They have been placed in charge of Dr. G. P. Magrini, who will be assisted by Professors L. de Marchi and T. Gnesotto, of the University of Padua.

Dr. Hendrik Antoon Lorentz, professor of mathematical physics in the University of Leiden, will give a course of lectures at Columbia University on the theory of electrons and its application to the phenomena of light and radiant heat. The program is as follows:

Friday, March 23, 4 to 6 P.M.; Saturday, March 24, 10 to 12 A.M.; and Friday, March 30, 4 to 6 P.M.—General principles; theory of free electrons.

Saturday, March 31, 10 to 12 A.M., and Friday, April 6, 4 to 6 P.M.—Emission and absorption of heat.

Saturday, April 7, 10 to 12 A.M.; Wednesday, April 11, 4 to 6 P.M.; and Thursday, April 12, 4 to 6 P.M.—The Zeeman effect. Propagation of light in ponderable bodies.

Thursday, April 26, 4 to 6 P.M., and Friday, April 27, 4 to 6 P.M.—Optical phenomena in moving systems.

Professor Alexander Müller, known for his work in agricultural chemistry, has died in Rysby, Sweden, at the age of seventy-eight years.

One or two computers will be needed in the near future at the Pasadena office of the Solar Observatory of the Carnegie Institution. Their work will consist in the measurement and reduction of photographs of the sun and of solar spectra. Applications may be sent to Mr. W. S. Adams, superintendent of computing division, Solar Observatory Office, Pasadena, Cal.

A beginning has been made with the building of the new Magnetic Observatory at Eskdalemuir, which is to take the place of the present observatory at Kew. The observations at Kew have been affected by disturbances caused by electric installations, etc. Eskdalemuir is fifteen miles from a railway, in a high-lying pastoral district.

The daughters of the late Dr. Edward Sang have given his collection of trigonometrical and astronomical calculations in manuscript to the Royal Society of Edinburgh. The gift also includes a collection of scientific manuscripts by Dr. Sang.

The twenty-third congress for 'Innere Medizin' will take place at Munich from April 23 to 26, under the presidency of Professor von Strümpell. An exhibition of medical preparations, apparatus and instruments will be held.

The Medical Record states that in spite of some opposition on the ground of interference with state rights, the house committee on interstate and foreign commerce has agreed to make a favorable report on a committee substitute for the Williams bill to extend federal control of quarantines. According to the plan proposed the secretary of the treasury is placed in direct control of quarantine, and is to administer it through the Public Health and Marine Hospital Service. The bill carries an appropriation of $500,000.

A bill has been introduced into both houses of the New York legislature, which prohibits the manufacture and sale of medicinal preparations containing alcohol or other narcotic or poisonous drugs unless the formula, both qualitative and quantitative, is printed on the label in plain English.

WE learn from the *Journal of the American Medical Association* that arrangements have been completed for the transfer of the medical department of the Newberry Library, Chicago, including the Senn collection on medical history, to the ownership and management of the John Crerar Library. This has been done partly because the natural relation of these books to the chosen field of the John Crerar Library and the lack of such relations to that of the Newberry Library make the transfer in many ways mutually advantageous, and partly because the medical profession of Chicago has urged strongly the desirability of a more central location.

THE Boston *Transcript* states that the Gray Herbarium, connected with the Bussey Institution, has recently received from the Botanical Museum at Copenhagen a valuable collection of some 300 specimens of Scandinavian and Iceland flora. The North American collection has been enlarged by exchanges with the Geological Survey of Canada. Mr. F. S. Mathews has been added to the herbarium staff as artist.

WE learn from *The Geographical Journal* that in consequence of the archeological discoveries made by Professor Grünwedel at Turfan (Eastern Turkestan) in 1903, the German government sent an expedition to the same place in the following year under the direction of Dr. A. von Lecoq, of the Royal Prussian Ethnological Museum. Dr. von Lecoq, assisted by Herr Bartus, arrived at Chugutchak in October, 1904, and thence traveled to Kara Khoja (Dakiyanos), in the vicinity of Turfan, remaining there nine months, and excavating a number of caves and stupas. The finds have been most abundant, some hundred boxes of antiquities having been sent to Europe. These antiquities consist of heads of statues, showing Greek and Indian influence, well-preserved wall paintings from ruined temples, coins, and a large quantity of manuscripts in no less than seven kinds of writings, namely, Uigur, Brahmi, Tibetan, Kük Turki, Manichæan (some manuscripts illuminated), Syriac and Chinese. Dr. von Lecoq and Herr Bartus left Turfan for Kashgar in October last, and at Kashgar they have been joined by Professor Grünwedel and Herr Phurt, who have arrived from Berlin *viâ* Russian Turkestan. The party is now preparing to go to Kuchar, where systematic excavations are to be undertaken.

AT a meeting of the Zoological Society of London, held on February 22, it was announced that it had accepted an interesting and valuable collection of Indian animals. The collection has been made by the government of Nepal for presentation to the Prince of Wales, who had kindly agreed to send it to the society's gardens for exhibition. The Duke of Bedford, the president of the society, had generously promised to defray the cost of transport to England. The council expect the animals to arrive in June of this year, and hope to arrange for their exhibition in the gardens as a separate collection during the coming summer and autumn.

IN its annual report to the Carnegie Trustees, the executive committee of the trust stated, as we learn from the London *Times*, that, under the scheme of allocation for five years of an annual grant of £40,000 among the four Scottish universities, which became operative in January, 1903, sums amounting to £38,860 had been claimed and handed over during the year 1905, making for the past three years a total expenditure of £97,240. On the subject of the scheme of endowment of post-graduate study and research for the academic year 1905–6, the report stated that appointments were made to sixteen fellowships and twenty-seven scholarships; and grants of various amounts were made to forty-three applicants. The total expenditure under this scheme was £4,526. In the research laboratory of the Royal College of Physicians, Edinburgh, the superintendent had reported that during the past year thirty-six workers held places and had been engaged in forty-nine investigations. Of these workers, thirty-two were graduates of Edinburgh University and nine held grants from, or were in other ways beneficiaries under the Carnegie Trust. The payment of class fees of beneficiaries had been carried out as in previous years. The total

number of beneficiaries from the institution of the trust in 1901 until December last was 6,325; and the total amount paid in fees on behalf of students for class attendances for the year 1905 was £47,853, as against £45,903 in 1904, £44,104 in 1903, and £40,285 in 1902.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. W. S. Bullard, of Boston, has given $50,000 to the Harvard Medical School, to establish a chair of neuro-pathology.

Mr. Andrew Carnegie has offered to give $75,000 to Amherst College on condition that an equal sum be given by others for the construction and endowment of a building for biology and geology.

Mrs. John C. Whitin, who gave the present observatory and the now practically completed addition to Wellesley College, has added a residence for the members of the observatory staff.

The Clarke School for the Deaf at Northampton, Mass., will receive an annual income of $1,500 to enlarge the training school facilities from the fund recently received by the Association for Teaching Speech to the Deaf, given to them by Dr. Graham Bell. Dr. Bell became heir to about $75,000 from the estate of his father, Dr. Melville Bell, the inventor of the system of visible speech, and he made over this sum to the association. His condition was that it should be used as a permanent memorial of his father's connection with the subject, the homestead in Georgetown, D. C., to become the office of the association, for printing, etc., and about half the property to have its income devoted to the training of teachers of the oral method.

The William H. Baldwin, Jr., Memorial Fund for the Tuskegee Institute amounts to more than $150,000.

The Goldsmiths' Company has made a grant of £10,000 to the Institute of Medical Sciences Fund, University of London, on the assumption that a site will be provided for the institute at South Kensington.

The Association of American Universities held its annual meeting at the University of California, Stanford University and San Francisco last week. The scientific program was as follows:

Interchange of professors in universities: Papers presented on behalf of the University of California, by President Benjamin Ide Wheeler, and of Harvard University, by Professor William James.

To what extent should professors engaged in research be relieved from instruction: Papers presented on behalf of Leland Stanford Junior University, by President David Starr Jordan, and of Yale University, by Professor Theodore S. Woolsey.

The reaction of graduate work on the other work of the university: Paper prepared by President Jacob Gould Schurman, presented by a representative of Cornell University.

The organization of the American university with especial reference to the changes in the conception of a 'faculty': Paper presented on behalf of Princeton University, by Professor Andrew F. West.

Norton A. Kent, Ph.D., has been elected to the chair of physics at Boston University and will enter upon his duties at that institution in the fall.

Dr. James Barnes has been elected associate in physics in Bryn Mawr College.

Dr. James Burt Miner, B.S. (Minnesota, '97), Ph.D. (Columbia, '03), has been appointed assistant professor of psychology at the University of Minnesota. Dr. Miner is at present assistant professor of philosophy at Iowa University. He will have charge of the new laboratory now being equipped at Minnesota and also of the work in educational psychology.

Dr. E. C. Moore, professor of education at the University of California, has been appointed dean of the coming session of the University of California Summer School. After the summer session Dr. Moore will go to Los Angeles to assume the duties of superintendent of schools of that city.

Professor George H. Palmer, of Harvard University, has been elected lecturer in ethics for next year at Yale University, and Dr. Henry Rutgers Marshall of New York City has been elected lecturer in esthetics and psychology.